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DEPARTMENT OF THE AIR FORCE

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# AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio



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AN ANALYSIS OF INCENTIVE-DRIVEN
COST REDUCTION METHODS FOR
MAJOR WEAPON SYSTEM
ACQUISITION PROGRAMS

THESIS

Daniel W. Sietman, Captain, USAF

AFIT/GSM/LSP/90S-27

The opinions and conclusions in this paper are those of the author and are not intended to represent the official position of the DOD, USAF, or any other government agency.

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# AN ANALYSIS OF INCENTIVE-DRIVEN COST REDUCTION METHODS FOR MAJOR WEAPON SYSTEM ACQUISITION PROGRAMS

THESIS

Presented to the Faculty

of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Systems Management

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Captain, USAF

September 1990

*Acknowledgments*

I would like to express my gratitude to Captain Gregg Garrett, my thesis advisor, for his encouragement and his many helpful suggestions in defining the direction of my research. His experience as a contracting officer provided an important perspective of the research topic that might have been otherwise overlooked. Gregg was also most helpful in suggesting sources for most of the background material used.

I would also like to thank Mr Roger Hollenbaugh, Major Mark Leuthold, and Captain Rob Shell, all of the C-17 System Program Office, for their suggestions and support of the research effort.

My greatest appreciation goes to my wife, [redacted] and my sons, [redacted] for their patience and support. Their loving understanding freed me to spend the time necessary to accomplish the research project.

Daniel W. Sietman

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## *Abstract*

This thesis investigated the framework of the acquisition cycle, the primary types of contracts used in major weapons system acquisition programs, and several incentive-driven cost reduction methods. The cost reduction methods studied were the Manufacturing Technology Program (ManTech), the Industrial Modernization Incentives Program (IMIP), Value Engineering (VE), Producibility, Reliability, and Maintainability. The goal of the research was to provide a framework to help program managers better understand the cost reduction potential of, and the interrelationships among, the study elements, when attempting to implement specific cost reduction candidates. The research revealed a strong link between the acquisition cycle and each of the other study elements, some indirect links between the various contract types and the cost reduction methods, and a number of interdependencies among the cost reduction methods. The framework developed consisted of five issues to consider: (1) the program environment, (2) the focus of the cost reduction candidate versus that of each cost reduction method, (3) the practicality of cost reduction methods, (4) the interrelationships among all cost reduction methods in use, and (5) the overall impact on the risk and incentive structure of the program.

# AN ANALYSIS OF INCENTIVE-DRIVEN COST REDUCTION METHODS FOR MAJOR WEAPON SYSTEM ACQUISITION PROGRAMS

## I. *Introduction*

### *Chapter Overview*

This chapter contains a background for the analysis of incentive-driven cost reduction methods used in major weapon system acquisition programs. The general issue is discussed, the specific problem investigated is stated, and the research objectives are presented. Also included in this chapter are the scope of the research and definitions of some terms used throughout the study.

### *General Issue*

> ... [A]s a result of competing national priorities, the real resources available for defense in the early 1990s are more likely to be less than in recent years. If we are to continue to protect our global interests, meet our responsibilities, and minimize the risks to our security, we must preserve essential military capabilities through ever more skillful use of the resources at our disposal. (4:1-2)

These introductory remarks from the July 1989 Defense Management Report to the President were followed in November 1989 by a call from Secretary of Defense Richard Cheney for a reduction of up to $180 billion in defense spending over the next six years (32:A16). The analysis and planning that determined the magnitude of that budget reduction call,

however, could not anticipate the results of the dramatic events that swept through Eastern Europe as repressive communist dictatorships in Warsaw Pact nations collapsed, the Berlin wall was dismantled, and even individual republics within the Soviet Union took steps to establish their own sovereignty. As the threat to the United States and her allies appeared to evaporate, calls for further reductions in defense spending came as no surprise. Clearly, today's defense acquisition program managers face many budgetary challenges in response to political and economic changes over the next few years. John Correll, Editor in Chief of *Air Force Magazine*, said, speaking of the United States forces of the future: "They may be smaller, but it is unlikely that they will be either very simple or very cheap" (5:2).

As part of the budget tightening process, managers of existing major defense acquisition programs are often called upon to find ways to reduce life cycle cost, but maintain performance and schedule requirements. According to Robert B. Costello, former under secretary of defense for acquisition, the cost structure of contracting should focus on providing incentives to reduce costs instead of on scrutiny of profits.

> Currently, profits are a fixed percentage of costs, so a more expensive program - no matter how effectively run - usually means higher profits for industry. This has become a lose-lose situation for the Government and defense industry. What is needed is a win-win situation, where contractors are rewarded, perhaps by higher profits, when they lower overall costs to the Government (6:68).

A number of methods are available for government program managers to use in providing contractors with incentives to actively pursue contract cost reduction candidates (1:33). These cost reduction methods are documented and defined in the body of existing government acquisition guidelines, including directives, instructions, regulations, specifications and standards; however, in actual practice, implementing a valid cost reduction candidate is often a difficult, complex task. This complexity can lead to delays in implementing cost reduction candidates, or prevent them from being implemented at all, resulting in a loss of potential cost savings.

For example, the C-17 System Program Office of the Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio, was faced with a shrinking budget, while, at the same time, development and acquisition costs were increasing. A number of cost reduction candidates were collected; however, evaluating them and planning the implementation of those found to be viable was a difficult and time-consuming effort (22).

### *Specific Problem*

This study examined the interrelationships among the phases of the acquisition process, the primary types of contracts used in major weapons system acquisition programs, and several incentive-driven cost reduction methods to

enhance the understanding and appropriate use of those methods by acquisition program managers.

*Research Objectives*

In order to address the specific problem, the following objectives were addressed:

1. Review the phases and milestones of the acquisition cycle in light of the changes resulting from the Defense Management Report.

2. Study the primary contract types used on major weapon system acquisition programs from an incentive-driven cost reduction perspective.

3. Study the intended purposes and implementation criteria of some common incentive-driven cost reduction methods.

4. Analyze the interrelationships among the incentive-driven cost reduction methods, contract types, and the acquisition process.

5. Provide an integrated framework within which an acquisition program manager can consider alternative incentive-driven cost reduction methods to apply in specific situations.

*Scope of Study*

This research study was limited in the contract types and cost reduction methods addressed. The contract types included were those most often used for major weapon system acquisitions: firm-fixed price, fixed-price incentive (firm target), cost-plus-incentive-fee, cost-plus-award-fee, and cost-plus-fixed-fee. Six often-used, incentive-driven cost reduction methods were included: the Manufacturing Technology Program (ManTech), the Industrial Modernization Incentives Program (IMIP), Value Engineering (VE), Producibility, Reliability, and Maintainability. The study was intended to

assist managers of major defense acquisition programs; however, the concepts could be easily applied to planning the structure of any acquisition program.

### *Limitations*

In response to the Defense Management Report, DoD Directive 5000.1, *Policies Governing Defense Acquisition*, and DoD Instruction 5000.2, *Defense Acquisition Management Policies and Procedures*, are being revised. The acquisition cycle described in this paper reflects the structure proposed in the 25 May 1990 draft versions of these documents. Some changes to these draft documents are quite likely by the time they are finally approved; however, any changes are not expected to significantly affect the results of this study. For the benefit of readers who may already be familiar with the acquisition cycle, the Appendix cross-references the new names of the acquisition cycle phases and milestones to those formerly used.

### *Definitions*

Terms frequently used throughout this thesis are defined as follows:

*Acquisition Cycle.* The acquisition cycle is the succession of phases and milestone decision points that define the process of developing a typical new weapon system and making it available to the intended user (10:II-1).

*Acquisition Program.* An acquisition program is an undertaking to provide a new or improved material capability in response to a validated need (11:2.101).

*Cost Reduction Method.* A cost reduction method is a means of decreasing the current life cycle cost projections of a program (26).

*Cost Reduction Candidate.* A cost reduction candidate is any specific concept, suggestion, alternative, or initiative that is thought to have the potential of decreasing the life cycle cost of a program (26).

*Exit Criteria.* The term exit criteria refers to the standards by which a system in the acquisition process is deemed to be ready to advance to the next phase of the acquisition cycle. At each milestone review, exit criteria from the previous acquisition phase are evaluated and new exit criteria are established for the next acquisition phase (10:II-4).

*Instant Contract.* An instant contract is a contract which has been negotiated and is on-going at the time in question. For VE purposes, the instant contract is the one under which a VECP is submitted (11:48.001). For IMIP purposes, instant contracts are the ones that have been negotiated prior to implementing the IMIP(s) (7:A-3).

*Life Cycle Cost (LCC).* The term life cycle cost refers to all costs of a system over its full expected life. The life cycle includes a research and development phase, an investment phase, an operating phase, and final disposal (23:1).

*Major Defense Acquisition Program.* An acquisition program is referred to as a major defense acquisition program if it is not classified as highly sensitive, and meets at least one of the following three conditions (17:2):

1. it is designated as a major program by the Under Secretary of Defense for Acquisition.

2. it has a total estimated cost of all research, development, test, and evaluation which exceeds $200 million based on constant fiscal year 1980 dollars or $300 million based on constant fiscal year 1990 dollars.

3. it has a total estimated cost of procurement which exceeds $1 billion based on constant fiscal year 1980 dollars or $1.5 billion based on constant fiscal year 1990 dollars.

*Memorandum of Understanding (MOU).* An MOU is a negotiated, non-binding document which ensures a general understanding of the intent and direction of the program or project being considered, and lays the groundwork for future contractual activity (12:2-7).

*Reliability Growth.* Reliability growth is the increase in reliability of a system as a result of using lessons learned in testing and development to further improve reliability (24:86).

*Tailoring.* Tailoring is the process of evaluating and modifying a set of potential requirements for a system acquisition, to ensure that only those necessary and cost effective are retained. Tailoring is often used in the context of applying common sense to a data requirements list or to other requirements spelled out in a military standard or specification (16:2).

*Tolerance Buildup.* Tolerance buildup is the overall out-of-tolerance condition that occurs when a number of components that are within the allowable tolerances, but only marginally so, are assembled into a system or subsystem (10:VI-C-4).

*Organization of the Study*

The study is organized as follows. Chapter II provides background information on the acquisition cycle, contract types, and incentive-driven cost reduction methods pertinent to this paper. Chapter III presents the study methodology. In Chapter IV, the interrelationships of the acquisition cycle, the contract types, and the cost reduction methods are explored. Conclusions and recommendations are presented in Chapter V.

# *II. Background*

## *Chapter Overview*

The purpose of this chapter is to provide the background necessary to understand how the cost reduction methods relate to the research problem. A great deal has been written on each of the specific cost reduction methods addressed in this thesis. While some studies and expository writings are cited, current government regulations and instructions were used as the primary source documents. This chapter first reviews the acquisition cycle as described in the 25 May 1990 draft versions of Department of Defense Directive (DoDD) 5000.1, *Policies Governing Defense Acquisition*, and Department of Defense Instruction (DoDI) 5000.2, *Defense Acquisition Management Policies and Procedures*. Next the most common contract types used for major weapon system acquisition programs are discussed. Finally, information on the cost reduction methods addressed in this study is presented.

## *Defense Acquisition System*

At the initiative of Deputy Defense Secretary David Packard in 1970, DoD Directive 5000.1, *Acquisition of Major Defense Systems*, was issued to implement a number of improvements to the defense acquisition process. This directive, and a number of other directives and instructions in the 5000 series became the basis for structuring and

managing defense acquisition programs (22:44). The current versions of DoDD 5000.1, *Policies Governing Defense Acquisition*, and DoDI 5000.2, *Defense Acquisition Management Policies and Procedures*, implement further improvements to the acquisition process as a result of Defense Secretary Richard Cheney's *Defense Management Report to the President* in July 1989 (17:1).

An "Acquisition Program" is defined in DoDD 5000.1 as,

> A directed effort, funded by the research, development, test, and evaluation appropriation or the procurement appropriations, that is designed to provide a new or improved material capability in response to a validated need. (17:2)

The policies established in DoDD 5000.1 are intended to provide an integrated system in which necessary, "affordable acquisition programs" will produce "quality products" within a management structure that promotes "efficiency and effectiveness" (17:I-1).

*Life Cycle Cost*. OMB circular A-109, issued by the Office of Management and Budget (OMB) in 1976 required that Life Cycle Cost (LCC) be a part of the acquisition process (23:4). In most cases, a system's operational and support costs far exceed the combined costs of all other life cycle phases. The operational and support concepts are determined early in the life cycle; therefore, decisions made during the research and development phase have a heavy impact on costs incurred when the system is deployed. For these reasons,

accurate projections and effective management are important to control life cycle costs (23:1).

*Acquisition Milestones and Phases.* Department of Defense Instruction 5000.2, *Defense Acquisition Management Policies and Procedures,* describes the acquisition process in terms of five "major milestone decision points" and five "acquisition phases." This framework is established to provide a basis for "comprehensive management and decision making" (10:II-1). Table 1 shows the overall relationship of the milestones and phases. This framework allows for the

Table 1

Milestone Decision Points and
Acquisition Phases

| DECISION POINT | LEADS TO ... |
|---|---|
| Milestone 0, Concept Studies Approval | Phase I, Concept Exploration & Definition. |
| Milestone I, Concept Demonstration Approval | Phase II, Demonstration & Validation. |
| Milestone II, Development Approval | Phase III, Engineering & Manufacturing Development, (and Low Rate Initial Production, if appropriate). |
| Milestone III, Production Approval | Phase IV, Production & Deployment, and Phase V, Operations and Support. |
| Milestone IV, Modification Approval (conducted during Phase IV as required) | major modifications or upgrades to the system. |

(10:II-2)

critical review of the system at logical intervals throughout its entire life cycle; however, individual acquisition plans

are structured for each program to minimize the time needed to accomplish its goals. Broad latitude is given in "tailoring" acquisition plans within the constraints of "common sense, sound business practice," and the policies stated in DoDD 5000.1 and DoDI 5000.2. Tailoring may include altering the number of phases, the major activities conducted within each phase, and the number of milestone decision points, but must stay within requirements established by law (17:4,5). For major weapons acquisition programs, recommendations on milestone decisions are made by the Defense Acquisition Board (DAB) to the Under Secretary of Defense for Acquisition (USD(A)) on whether a specific program should begin each acquisition phase (10:II-3). Documentation prepared by the program manager and the functional staff is the primary means of providing the SECDEF with sufficient information upon which to base his decision. Although limited to that required to support the decision process, a substantial amount of documentation is necessary (10:XI-C).

*Milestone 0: Concept Studies Approval.* At the Milestone 0 review, the decision is made whether to launch studies of alternative concepts in response to a validated mission need. The smallest combination of alternatives with the greatest potential to satisfy the need is then approved for study. Any special information or analyses required for the Milestone I review is also specified (10:III-4,5).

*Phase I: Concept Exploration and Definition.* During Phase I, alternative concepts are explored and the most promising are defined in sufficient detail to prc, acquisition strategy and initial cost, schedule and performance objectives. High risk areas are also identified along with risk management approaches (10:III-6,7). Activities during this phase consist primarily of studies or analyses to determine the feasibility of the competing alternatives; therefore, any contracts normally cover relatively short time periods (30:11,12).

*Milestone I: Concept Demonstration Approval.* At the Milestone I decision point, the results of the Concept Exploration and Definition Phase are reviewed to determine whether a new acquisition program should be established. For each concept approved, a "Concept Baseline" consisting of initial cost, schedule and performance objectives is established. Any "exit criteria," accomplishments requ to proceed beyond Phase II, are also established (1:III-9,10).

*Phase II: Demonstration and Validation.* With appropriate authorization, one or more concepts contin the Demonstration and Validation Phase. The selected alternative or alternatives are developed in greater to obtain better estimates of feasibility, technical and costs (10:III-12,13). Hardware prototyping, stuc

analyses, or a combination of studies and prototyping are typically used to evaluate each alternative (30:17).

*Milestone II: Development Approval.* At the Development Approval milestone, the results of the Demonstration and Validation Phase are evaluated. If approved, a concept proceeds into Engineering and Manufacturing Development. A "Development Baseline" is established, containing updated cost, schedule, and performance objectives. If development approval is given, often a commitment is also made for low-rate, initial production (LRIP). In the appropriate cases, LRIP quantities are established at Milestone II. Exit criteria for Phase III are also set (10:III-15,16).

*Phase III: Engineering and Manufacturing Development.* During Engineering and Manufacturing Development, the design approach developed and approved in Phase II is developed into a stable system design, the manufacturing and production processes are validated, and pre-production versions of the system are built and tested to show that the system meets contractual, mission, and operational requirements (10:III-18,19). A critical component of the development phase is a thorough test program. Test results often determine whether additional resources will be committed to the program (30:19).

*Milestone III: Production Approval.* The Milestone III review is held to evaluate the results of the Engineering and Manufacturing Development Phase and to establish the "Production Baseline" of program cost, schedule and performance objectives. Again, exit criteria for the next phase are established (10:III-21,22).

*Phase IV: Production and Deployment.* In Phase IV, the actual system, any required support and training equipment, initial spare parts, and facilities are produced for delivery to the final user. Also, an "operational capability" that satisfies the identified mission need is established. Testing begun during Engineering and Manufacturing Development is continued, and new testing is started to verify and monitor continued compliance with performance and quality requirements (10:III-24).

*Milestone IV: Major Modification Approval.* During the Production and Deployment Phase, if necessary, a Milestone IV review is held to determine whether major modifications or upgrades are warranted (10:III-25,26). The need is considered by reviewing the system's continued utility in meeting original or current mission requirements, changes in the defense threat assessment, and the impact of new technology. Possible decisions could range from continuing the *status quo* to retiring the system and considering the start of a new program (30:24). For those programs where major modifications are approved, the phase

the program is to enter is selected, an appropriate acquisition strategy and baseline are established, and exit criteria for the next phase are specified (10:III-25,26).

*Phase V: Operations and Support.* The Operations and Support Phase overlaps Phase IV. It begins at "Initial Operational Capability" (IOC), when the system is declared ready for operational use, or at "Primary Management Responsibility Turnover" (PMRT), when the management responsibility transitions from the development agency to the maintaining agency. Phase V then continues until the system is retired from the inventory. During the Operations and Support Phase, the system's ability to continue to meet the mission need is continually assessed and any shortcomings or deficiencies are identified (10:27).

*Contract Types*

The contracts used for major defense system acquisition programs can be divided into two basic types, those with a fixed price, and those for which the final price is determined on a cost reimbursement basis. Fixed-price contracts establish a set price for the contracted goods or services which cannot be exceeded regardless of the costs to produce those goods or services (11:16.101). On cost reimbursement contracts, the government pays for all reasonable, allowable, and allocable costs the contractor incurs, up to the original estimate. An estimate of the total cost to perform the required work is established. If

the contractor exceeds this estimate without the authorization of the government contracting officer, he does so at his own risk (11:16.301-1).

*Fixed-Price Contracts.* The amount of profit made by the contractor on fixed-price contracts is tied directly to the costs of performing the contract; higher costs result in lower profit and lower costs yield higher profits (28:6.2.1b). Two types of fixed-price contracts, firm fixed-price (FFP) and fixed-price incentive-firm target (FPIF), are covered in this study.

*Firm Fixed-Price (FFP).* In firm fixed-price contracts, the price is negotiated and set prior to the beginning of any work. As shown in Figure 1, the contractor's profits are directly related to his success in

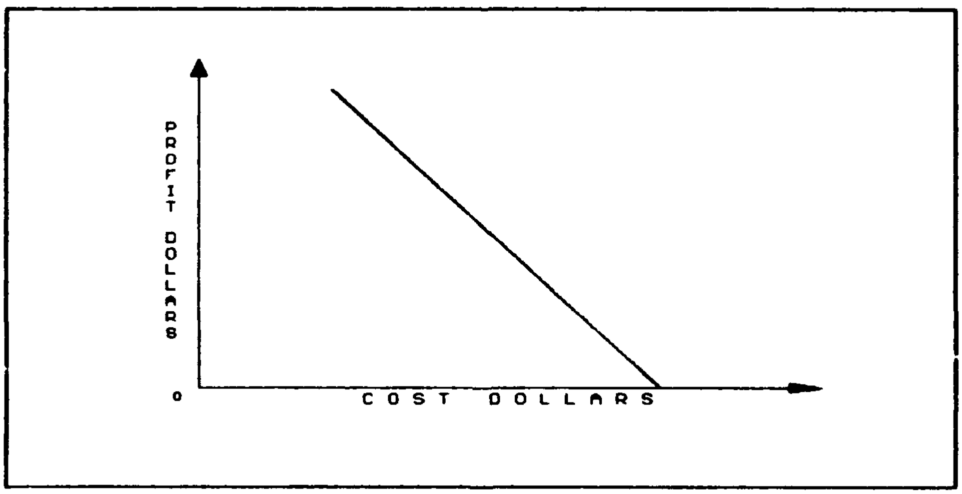


Figure 1. FFP Contract Cost/Profit Relationship (27:37)

keeping costs low. The price cannot be adjusted simply because the contractor experiences losses during contract

performance, unless the government is responsible for the cost impact or delay. The contractor bears responsibility for all costs of performing the work, including any resulting profit or loss. The Federal Acquisition Regulation (FAR) requires that a FFP contract be used, unless there is no reasonable method of determining a firm price (11:16.103(b)).

*Fixed-Price Incentive-Firm Target (FPIF).* If program uncertainties are too great to establish a firm price, but not great enough to justify a cost-reimbursement type contract, a fixed-price incentive-firm target contract might be used (28:6.2.1c). As shown in Figure 2, the target cost, target profit, ceiling price, and sharing ratios for cost overruns and underruns are negotiated for an FPIF contract. Target price can be determined as the sum of

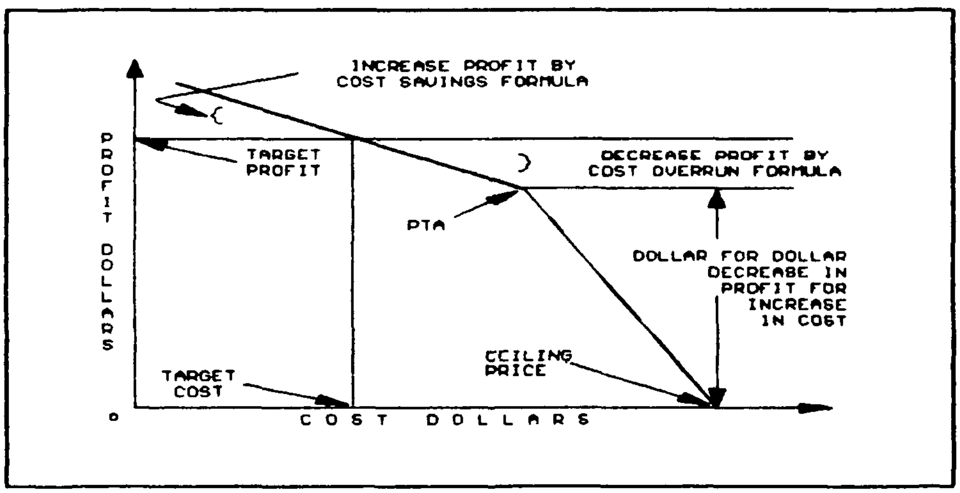


**Figure 2.** FPIF Contract Cost/Profit Relationship (27:37)

target cost and target profit, but is sometimes also included in the contract. If final costs of the contract are less

than the target cost, the contractor's profit is increased by a percentage of the savings. If costs exceed the target cost, the contractor's profit is decreased by a percentage of the excess costs. If costs exceed the "Point of Total (Cost) Assumption" (PTA), the contractor assumes cost liability as he would on an FFP contract, losing a dollar of profit for a dollar increase in cost. The government's obligation is capped at the ceiling price. If costs exceed the ceiling price, the contractor's profit is reduced to zero, and the contractor must completely absorb any further contract costs (27:32). Although cost reduction is the primary concern in establishing FPIF contracts, incentives may be based upon other contractor performance factors such as system performance or delivery schedule (25:6).

*Cost Reimbursement.* Under cost reimbursement contracts, the government retains greater flexibility in managing the overall performance of the contract, because the government contracting officer can authorize additional funding without receiving new consideration from the contractor (28:6.2.1b). The essential difference among the various cost reimbursement contract types centers around how the fee, if there is one, is paid to the contractor. The cost reimbursement contract types covered in this study are cost-plus-incentive-fee (CPIF), cost-plus-award-fee (CPAF), and cost-plus-fixed-fee (CPFF).

*Cost-Plus-Incentive-Fee.* Cost-plus-incentive-fee contracts provide a fee payment arrangement in which the final fee is based on how total allowable costs compare to a predetermined target cost. As shown in Figure 3, CPIF contracts must have a target fee, minimum and maximum fees, and a formula for final fee adjustment in addition to the

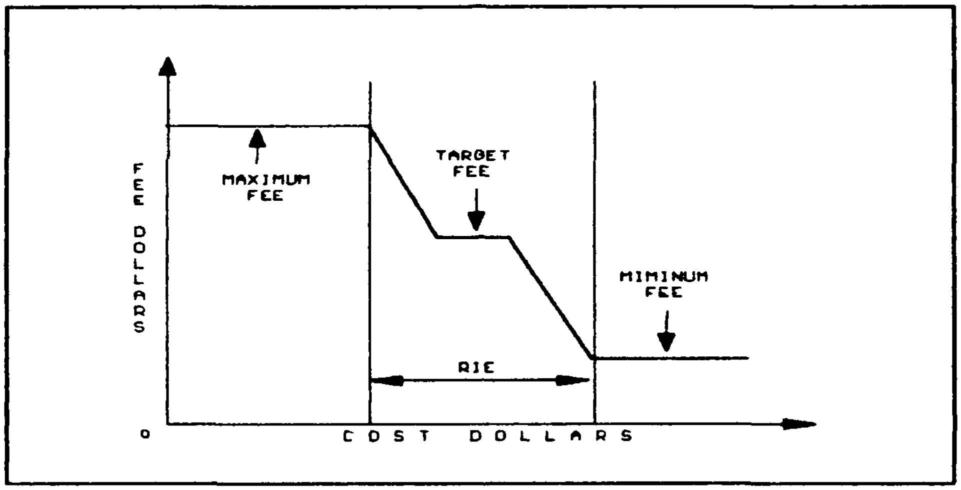


**Figure 3.** CPIF Contract Cost/Fee Relationship (27:37)

target cost. Upon completion of the contract, the total fee paid to the contractor is determined. If total cost was less than the original target, a share of the cost savings is added to the target fee. If the target cost was exceeded, the target fee is decreased by a share of the overrun. Between the minimum and maximum fees is the Range of Incentive Effectiveness (RIE) (11:16.404-1).

*Cost-Plus-Award-Fee.* In cases where incentives are still desired, but measurement of performance objectives is subjective in nature, cost-plus-award-fee contracts might be

used. Figure 4 shows that the CPAF contract provides a fee consisting of two parts, a base fee and an award fee. The

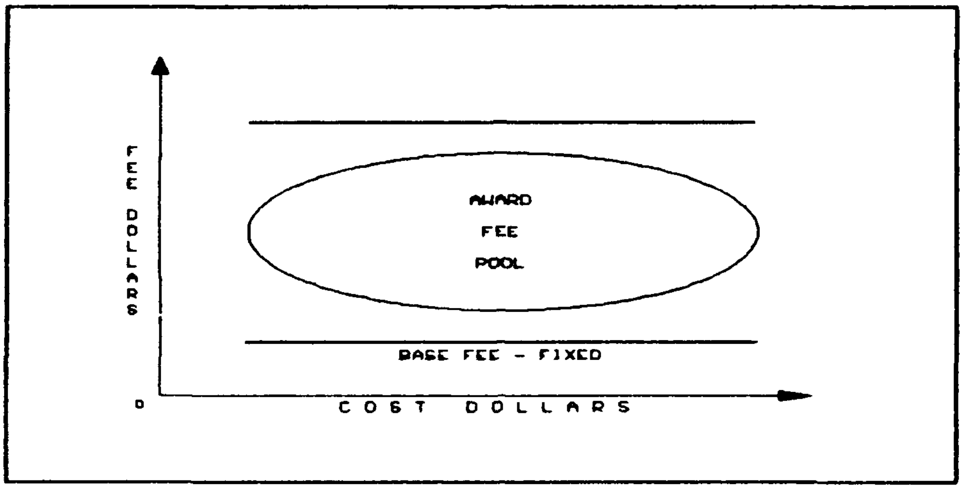


**Figure 4**. CPAF Contract Cost/Fee Relationship (27:37)

contractor may earn all or only part of the award fee. The amount earned is based on the government's subjective evaluation of the contractor's performance in accordance with projected criteria; such as quality, timeliness, ingenuity, and cost effectiveness. The contract must contain an award fee plan which includes when the contractor will be evaluated as well as the criteria to be used in determining the amount of the award (11:16.404-2).

*Cost-Plus-Fixed-Fee*. Under cost-plus-fixed-fee contracts, a fixed fee is negotiated at the beginning of the contract, and is not affected by the actual contract costs, as shown in Figure 5. Adjustments to the fee, however, can be made in consideration for approved, negotiated changes to the work required by the contract (11:16.306).

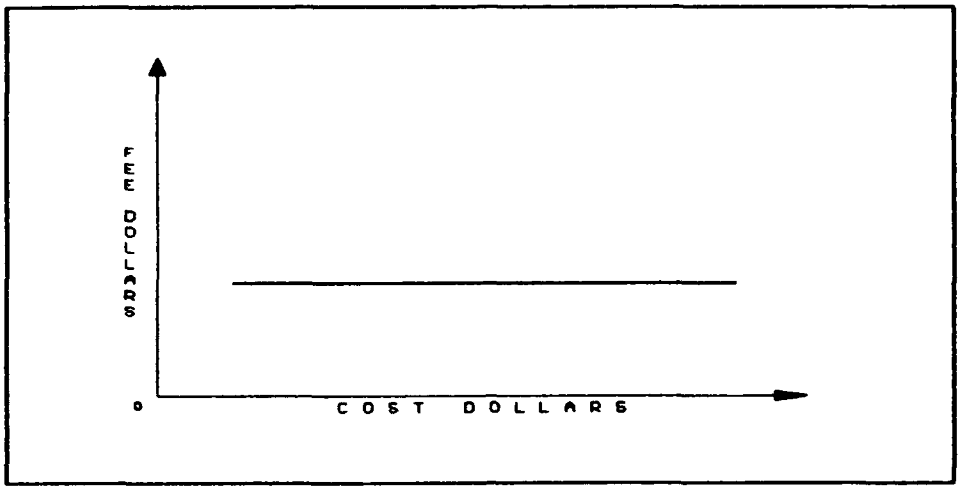


**Figure 5**. CPFF Contract Cost/Fee Relationship (27:37)

*Cost Reduction Methods*

A number of programs, policies, and concepts have been developed over the last three decades, each designed to help control some aspect of the life cycle cost of government purchases (33:1-1). The remainder of this chapter describes the cost reduction methods considered in this study.

*Manufacturing Technology Program (ManTech).* The Manufacturing Technology Program was established in 1947 to "enhance productivity, increase quality, and reduce life-cycle cost of weapon systems" (9:1) by investing Department of Defense funds in new or improved manufacturing technologies. Department of Defense Instruction 4200.15, *Manufacturing Technology Program*, defines manufacturing technology as

> Information that is, will, or may be used to define, monitor, or control processes and equipment used to manufacture or remanufacture DoD material. (14:2-1)

The focus of ManTech is to fund the research and development of specific manufacturing technologies identified as having the potential of supporting some Department of Defense requirement. The desired result of ManTech is to benefit both the government and industry by (14:1,2):

1. improving production costs and schedules of weapons systems and components;

2. making advanced manufacturing processes, techniques, and equipment available to reduce the costs of acquiring, maintaining, and repairing DoD materials;

3. encouraging the use of successful manufacturing technologies on full-scale production programs as well as in the research and development arena;

4. encouraging industry to make capital investments in new plants and equipment by reducing the cost and risk of applying new and improved manufacturing technologies; and

5. making information on the results of ManTech projects available throughout the defense industry.

ManTech funding is specifically disallowed if funds may be obtained through some more appropriate means. DoDI 4200.15 lists five examples in which ManTech funding is inappropriate.

a. Routine application of existing technology for the production of specific parts.

b. Investments specifically intended to change an end item's design.

c. Purchase of off-the-shelf capital equipment, unless it constitutes a minor portion of the investment and is required to establish the first-case application of the manufacturing process.

d. Performance testing of material produced using MTP [ManTech Program] deliverables, except to validate the manufacturing process.

e. Implementation of manufacturing technology beyond the first-case, factory floor application. (14:3)

A project disqualified from ManTech for one of these five reasons might still be useful if it meets the criteria of another cost reduction method.

*Industrial Modernization Incentives Program (IMIP).* An Industrial Modernization Incentives Program is a formal business agreement between the government and industry which provides incentives to contractors to accelerate the modernization of equipment and management techniques used in their facilities (7:1-1). Several incentive methodologies may be used. Government "seed money" may be used for a factory analysis to identify potential IMIP opportunities, or for project development (7:4-6). A second incentive methodology is known as "protected sharing." Under the protected sharing arrangement, the incentive is paid to the contractor out of the savings generated by the IMIP, and the government receives the balance of the savings in reduced hardware costs. The "directed incentive" methodology is a variation of protected sharing, often used when a contractor has frequent dealings with several government customers or makes several different products for the government. Under the directed approach, a single program or agency pays the entire incentive, even if the benefit to that program or agency is less than the award. The net benefit to the government, however, must be positive (7:4-4). Another

methodology is paying the contractor a "Productivity Savings Reward" (PSR). The amount of the PSR is a negotiated portion of the net DoD savings attributable to the contractor's participation in an IMIP. PSRs may be applied to future as well as existing contracts (7:A-6). Finally, the incentives may be "market-based." The benefits to the contractor are a stronger market posture with an opportunity to increase market share. The government benefits through lower prices and by stimulating competition (7:4-4,4-5).

The *Industrial Modernization Incentives Program Guide to Program Execution* identifies seven elements, shown below in Figure 6, as forming the nucleus of IMIP. An IMIP typically

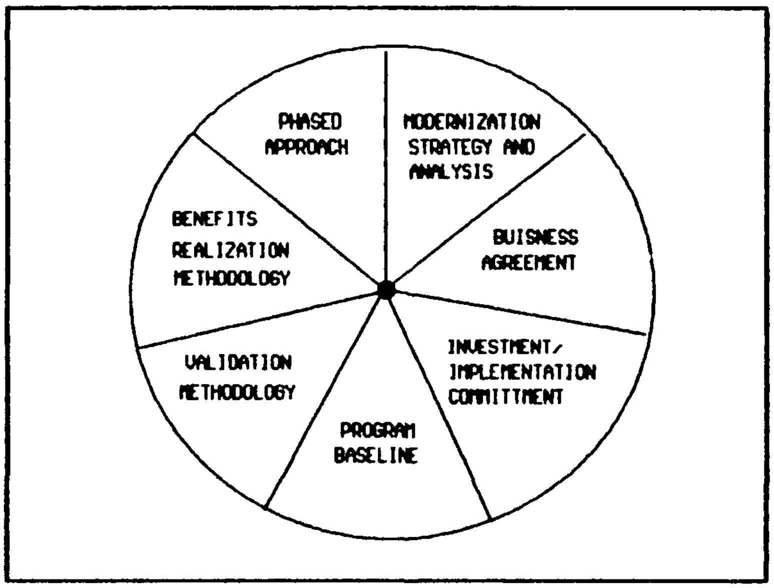


**Figure 6.** IMIP Elements (7:2-17)

uses a "three phased approach" (7:2-17): Phase I is an analysis of the factory to identify potential IMIP opportunities, Phase II is the development and demonstration of the projects that have greatest potential, and Phase III

is the implementation of projects successfully completing Phase II (7:1-2,1-3). Flexibility exists to structure a given program without Phase I or without Phase II as specific needs dictate (7:2-17). Whether or not Phase I is part of a specific IMIP, a "modernization strategy and analysis" (7:2-18) is necessary to establish the need for a program. The "business agreement" (7:2-18) is the foundation of an IMIP. It defines the structure and content of each of the other six elements. An "investment/implementation commitment" (7:2-18) is made to ensure the appropriate follow through for a successful program. This commitment is the element that most clearly distinguishes IMIP from ManTech. A "program baseline" (7:2-18) must be established to define the beginning point, or "as is" condition, upon which the IMIP will build. The parties must agree on a "validation methodology" (7:2-19), *i.e.*, how the results of the IMIP are to be measured. Finally, a "benefits realization methodology" (7:2-19) is established. Both the government and the contractor must be satisfied that each will benefit from the program. The specific expected benefits should be defined and clearly understood at the beginning of the program. Although the application of the seven elements may vary from program to program, total exclusion of any one of them indicates the program might not qualify as an IMIP.

*Value Engineering (VE).* Value Engineering is a formal technique of identifying and suggesting methods of reducing

overall life cycle costs and sharing the resultant savings with the contractor (11:48.101(a)). The Federal Acquisition Regulation (FAR) requires all initial production contracts for major system acquisition programs to include a Value Engineering Program Requirement (VEPR) clause unless the contractor has a proven VE program in place, or unless the contract was awarded competitively (11:48.102(d)(2)). VE contract clauses are written to either encourage voluntary use of VE, or require the contractor to conduct a VE program. Under the voluntary, or Value Engineering Incentive (VEI), approach, contractors use their own resources to prepare and submit recommendations. Under the mandatory VEPR approach, contractors are paid to conduct the VE program (11:48.101(b)). Contractor originated recommendations submitted under either the VEPR or the VEI approach are called value engineering change proposals (VECPs); government originated recommendations are called value engineering proposals (VEPs) (18:1-5).

If a VECP is approved, the contractor may receive a share of (11:48.001):

(1) the savings on the "instant contract," the contract under which the VECP was submitted;

(2) the "concurrent contract savings" from other contracts that are on-going and definitized at the time the VECP is accepted and use essentially the same affected items;

(3) the "future contract savings" from future contract units scheduled for delivery during the "sharing period"; and

(4) any "collateral savings" from cost reduction of Government operation, maintenance, logistics support, or Government-furnished property.

In the case of services and supply contracts, concurrent and future savings refer to contracts awarded to other contractors as well as to those awarded to the contractor who submitted the VECP (2:10-11). The Government/contractor share ratio of the savings is determined by the type of contract, the type of savings, and whether the contractor's participation is voluntary or mandatory as shown in Table 2 from the FAR (11:48.104-1). The "sharing period" begins with

Table 2

Government/Contractor Shares of Net Acquisition Savings (figures in percent)

| Contract Type | Sharing Arrangement | | | |
|---|---|---|---|---|
| | Incentive (voluntary) | | Program Requirement (mandatory) | |
| | Instant contract rate | Concurrent and future contract rate | Instant contract rate | Concurrent and future contract rate |
| Fixed-price (other than incentive) | 50/50 | 50/50 | 75/35 | 75/25 |
| Incentive (fixed-price or cost) | * | 50/50 | * | 75/25 |
| Cost reimbursement (other than incentive)** | 75/25 | 75/25 | 85/15 | 85/15 |

* Same sharing arrangement as the contract's profit or fee adjustment formula.
** Includes cost-plus-award-fee contracts.

(11:48-3)

government acceptance of the first unit incorporating the VECP and lasts until the latter of three years, or the scheduled delivery date of the last item affected by the VECP under the instant contract (11:48.101).

To qualify as a VECP, a recommendation must meet two basic requirements: it must require a change to the instant contract to be implemented, and it must result in an overall reduction in cost to the Government. The Federal Acquisition Regulation (FAR) requires that the cost savings be realized by means other than (11:48-2):

(1) sacrificing essential system functions or characteristics;

(2) simply altering the quantities of end items delivered;

(3) reducing development or R&D test quantities based only on previous testing results;

(4) simply changing the contract type.

Arnavas and Ruberry state that the most common VECPs and VEPs submitted are

> ... suggestions for reducing costs by modifying the specifications or drawings to allow the use of simpler methods, less expensive material or components, or other changes to the work which will not adversely affect the product ... (2:10-10)

*Producibility.* In *Best Practices*, W. J. Willoughby stated,

> Producibility is an engineering function directed toward achieving a design which is compatible with the realities of the manufacturing capability of a contractor. More specifically, producibility is a measure of the relative ease of manufacturing a product. (19:4-28)

Consistent with this definition, producibility is addressed as part of the design process (19:4-25) and as part of the manufacturing plan (19:6-1). DoDI 5000.2 also states that, as an integral part of the design process, producibility is a design requirement for weapon system development. It is a critical factor in determining whether a system is ready for the transition from development to production. To adequately prepare for this transition, DoDI 5000.2 requires that producibility efforts begin when a system reaches Milestone I, Concept Demonstration Approval, and continue through the production phase (10:VI-N-2).

The goals of producibility efforts are to achieve reduced manufacturing costs, lead times, and cycle times, and to minimize the use of strategic or critical materials by simplifying the design of an item and stabilizing the manufacturing processes (10:VI-N-2,3). MIL-STD-1528A, *Manufacturing Management Program,* states that producibility is a result of "a coordinated effort by systems/design engineering and manufacturing/industrial engineering" to ensure that functional units can be produced to the required performance and quality standards, in the desired quantities, and at the desired rate (13:4). Typically, producibility issues are addressed by requiring the contractor to "establish and maintain an effective manufacturing management program" (13:6), in accordance with MIL-STD-1528A. Contractor compliance is then monitored by including the Manufacturing Plan on the contract data requirements list

(CDRL) and by conducting a series of government reviews (13:12,14).

Figure 7 is a checklist for the design process given in *Best Practices*, where Willoughby maintained that the

CHECKLIST

✔ Does the contractor's corporate policy include producibility as part of design reviews?

✔ Are manufacturing and producibility personnel involved in the design process?

✔ Are proof of manufacturing models required prior to production?

✔ Are proven manufacturing processes being used whenever possible, with trade studies performed to justify the use of new technology?

✔ Are design and manufacturing engineers collocated during development?

✔ Are production readiness reviews planned incrementally?

Figure 7. Design Process Checklist (19:4-30)

manufacturing plan should be developed early in the program, and continuously updated (19:6-2). Failure to do so

> ... encourages late planning for product manufacture and precludes tradeoffs between manufacturing process alternatives and product design configurations. This late planning causes many "surprise" product redesign efforts for producibility. (19:6-4)

*Reliability*. Reliability is the attribute of an item, expressed as a probability, that the item will function as intended for a given time period under specified operating

conditions (10:XV-10). MIL-STD-785B, *Military Standard Reliability Program for Systems and Equipment Development and Production*, establishes guidelines for reliability programs and requirements. The stated purpose of a reliability program is "to support economical achievement of overall program objectives" (16:4). The reliability goals of a given system are based on that system's operational requirements (10:VI-C-2). As the system design matures, test and failure data are used to improve overall system design, the reliability of a system is expected to experience "growth" (24:88).

The focus of reliability programs is on both mission and logistics reliability parameters. Mission reliability is quantified by parameters such as how frequently a system fails or breaks and whether a system can successfully complete a mission. Logistics reliability is quantified by parameters such as the frequency of maintenance demand and the frequency of logistics demand (10:VI-C-2). Common design considerations considered favorable from a reliability standpoint are a simple design, a minimum number of parts, off-the-shelf parts with well established reliability characteristics, and redundant or back-up subsystems where necessary (10:VI-C-2,3).

The impact of increased reliability on life cycle cost is generally an increase in initial investment costs and a decrease in later operating and support costs as shown in Figure 8 (24:2).

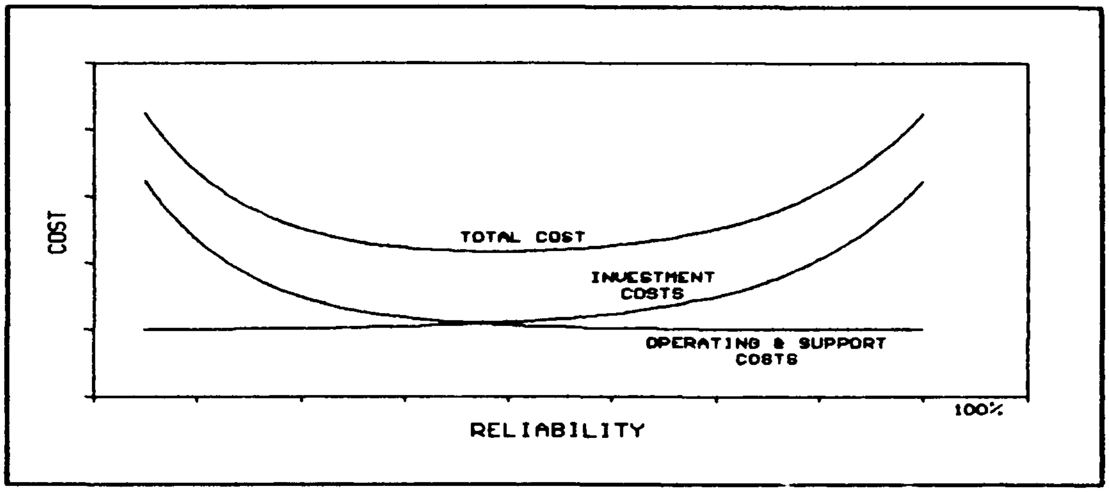

**Figure 8**. Reliability and Life Cycle Cost (24:3)

*Maintainability.* The maintainability of an item describes the ability to keep it in, or return it to, a specified condition when maintenance is done by appropriately trained individuals using designated procedures and resources (10:XV-6). MIL-STD-470B, *Military Standard Maintainability Program for Systems and Equipment,* establishes guidelines for maintainability programs and requirements. The stated objective is "to assure attainment of the maintainability requirements of the acquisition" (15:5) Increased maintainability has an effect on life cycle cost similar to that of reliability: higher investment costs and lower operating and support costs (21:28).

The focus of maintainability programs is on servicing, preventive and corrective maintenance, battle damage repair, manpower quantities and skill levels, special tool and test equipment needs, and troubleshooting capabilities (10:VI-C-2). Maintainability analyses should be done prior to the detailed design. The results of the analyses are then used

to develop specific maintainability requirements. Common maintainability design considerations are any necessary battle damage repair techniques, minimizing the number of tools needed for maintenance, and the most effective combination of automated, semi-automated and manual diagnostic techniques to be used for troubleshooting (10:VI-C-3). Before a system is approved for production, a maintainability demonstration is conducted to verify that maintainability requirements have been met (10:VI-C-3).

### *Summary*

This chapter has briefly described the acquisition cycle used by the Department of Defense and the types of contracts used in the acquisition of major weapons systems. Also described were the cost reduction techniques of the ManTech Program, the Industrial Modernization Incentives Program, Value Engineering, Producibility, Reliability, and Maintainability.

# III. Research Methodology

## Chapter Overview

The purpose of this chapter is to outline the methodology used to address the specific problem and meet the research objectives given in Chapter 1. First, the rationale for the chosen research design is presented. The importance of the acquisition cycle to the study is then discussed. Next, the basis for the selection of contract types and cost reduction methods used in the study is given, followed by a description of the method of data collection. The chapter concludes with a discussion on the method of analysis.

## Research Design

This research project is a formal, descriptive study of incentive-driven cost reduction methods. C. William Emory, in *Business Research Methods*, states that a formal, descriptive research design is appropriate when the research problem has been "crystallized" (20:59), and the objective of the study is "to learn the who, what, when, where, and how of a subject" (20:69). The problem under consideration and the objectives of this study, as described in Chapter 1, meet these criteria.

## The Acquisition Cycle

A review of the acquisition process is important to this study for a number of reasons. First, the acquisition cycle of milestone decision points and development phases provides

the basic framework for understanding and working with the acquisition process. Secondly, many significant changes have been introduced into the process over the past year. Even individuals very familiar with defense acquisition will find many changes in the terminology and focus of the revised 5000 series of Department of Defense directives and instructions. Keeping current with the acquisition process will aid the adjustment to anticipated future changes as well. For example, at the time of this writing, the House Armed Services Committee is considering a proposal described as "a major departure from traditional weapons-buying plans." The proposal, if enacted, would require demonstrations of effectiveness for major subsystems prior to production approval for new aircraft (31:A14). Finally, the analysis of the acquisition cycle was included to provide a complete view of the interaction of the cost reduction methods within the context if the acquisition process.

*The Contract Types*

An analysis of contract types was included for two primary reasons: (1) each contract type is slightly different in how the contractor is motivated to control or reduce costs; and (2) part of the study's objective was to determine if contract type has any impact on implementation of any of the cost reduction methods. The scope was limited to types most often used for major system acquisitions.

### *The Cost Reduction Methods*

Six cost reduction method were analyzed: the Manufacturing Technology Program (ManTech), the Industrial Modernization Incentives Program (IMIP), Value Engineering (VE), Producibility, Reliability, and Maintainability. Although other methods exist, these six were selected for study because:

1. each provides the contractor with some incentive to reduce costs;
2. each plays a significant role in the acquisition planning process, particularly in preparing the program to move from development into production;
3. all are normally required on major system acquisitions;
4. each uses the life cycle cost approach; and
5. each requires some investment early in the program to realize later benefits.

### *Data Collection*

Since this was a descriptive study, the literature review and background search provided the data used. There are a plethora of articles, written over the past decade, on the cost containment problems in defense acquisition. Although some books, articles, and studies were used to better understand the issues, the principal regulatory documents governing each of the elements presented in the paper were used as primary sources. Several personal interviews were conducted, as well, to help clarify important points. Finally, additional background information was obtained through attendance at a National Education Seminar

conducted in Dayton, Ohio by the National Contract Management Association.

### *Method of Analysis*

In keeping with the descriptive research design, a qualitative study of cost reduction methods was accomplished. The first step in the analysis was to examine how the potential to conduct cost reduction activities is affected by decisions made as a system progresses through each phase in the system acquisition cycle. The second step was to consider the application and suitability for use of the various contract types. Next, each specific incentive-driven cost reduction method was analyzed. Particular interest was devoted to the criteria which would either allow or exclude the use of the cost reduction method. The final step was to examine the interrelationships of the methods with each other, and with the various phases of the acquisition cycle.

### *Summary*

This chapter presented the research design for this thesis and the rationale for selecting each of the elements for study.

# IV. Analysis

## Chapter Overview

The appropriate use of each cost reduction method presented in Chapter II is clearly stated in defense acquisition regulations, directives, instructions, and standards. To effectively reduce the life cycle cost of a system, however, the manager needs to see how the program phase, the contract type, and each of the methods impact each other. This process is portrayed in Figure 9 as looking into an octagonal box through a window on each of the eight sides.

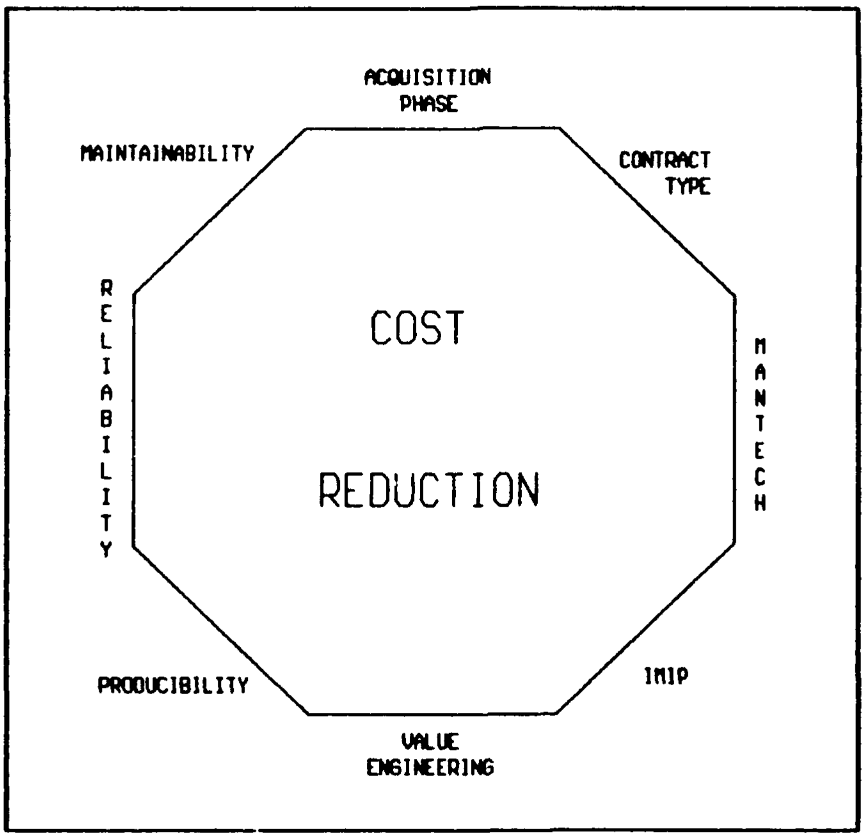


**Figure 9.** Cost Reduction Methods

Chapter IV analyzes the interrelationships among the cost reduction methods. The analysis considers how one might effectively use available cost reduction methods by examining each facet of the octagon in Figure 9 for answers to the following questions.

- What is the cost reduction potential?
- What specific tasks or activities are necessary?
- How do the tasks or activities from one facet integrate with tasks or activities from the other facets?.

The result of the analysis is a framework for determining which method or methods should be used to implement a potential cost reduction candidate.

*Acquisition Phase*

Given the complex nature of the acquisition environment, the typical program manager will make many adjustments in response to stimuli ranging from direct internal programmatic problems and requirements to external issues with an indirect impact. Each decision made has the potential to influence the overall cost profile of the system. The impact of decisions affecting major cost, schedule, and performance issues is fairly obvious. A more challenging task is determining the impact of decisions such as: structuring the cost and savings sharing parameters of a cost reimbursement type contract; deciding when to begin a ManTech project; or choosing between a mandatory or voluntary VE program. Another subtle, but important, aspect is recognizing how much each decision limits the range of choices available for the

next decision. The cost savings to be realized from any of the cost reduction methods discussed in this paper depend heavily on the management decisions made in each of the acquisition phases.

*Basic Framework.* The five milestone decision points and five acquisition phases, as shown in Figure 10, provide the basic framework for management decisions throughout the life of the acquisition program.

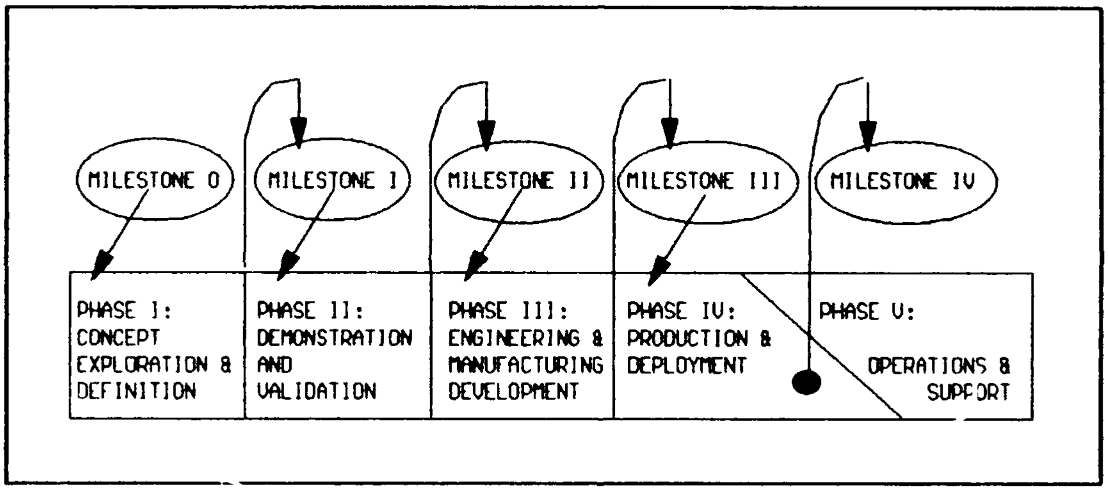


Figure 10. Acquisition Phases and Milestones (10:II-1)

*Cost Reduction Potential.* The potential for each decision made during the acquisition cycle to have a significant impact on cost reduction is much greater in the earlier phases before the system design is firmly established. At the same time, estimates and projections used to assist the decision making process have a greater degree of uncertainty and variability in the earlier phases. To prevent potentially catastrophic cost escalations caused

by inadequate data, the decision support data base should be updated constantly, and flexibility to modify the direction of the program based on new data should be retained as long as possible.

Figure 11 shows how the cost reduction potential varies throughout the acquisition cycle. During the Concept

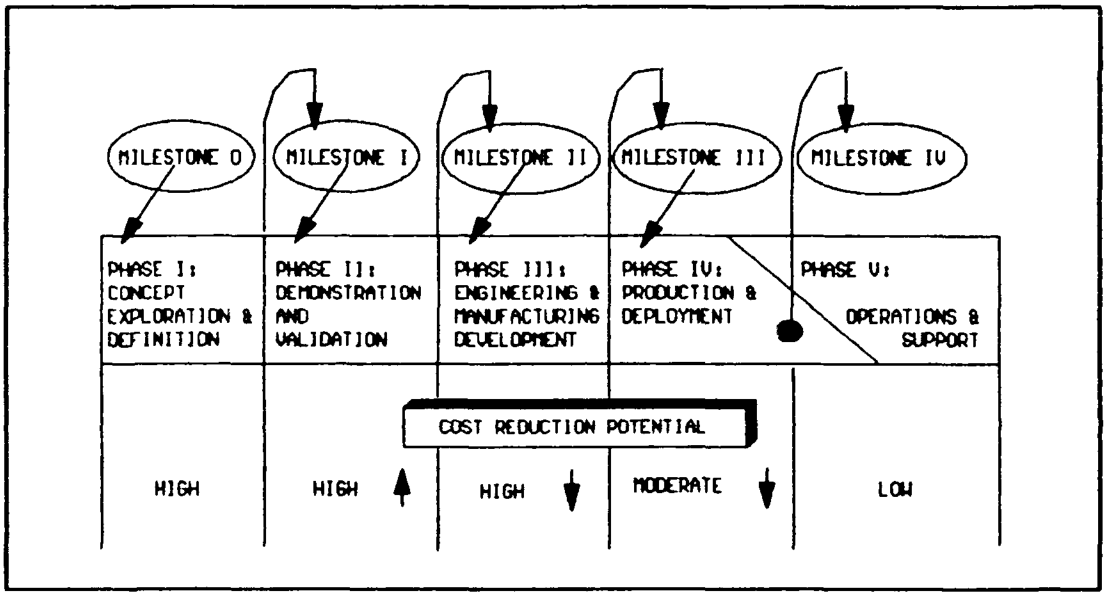


**Figure 11.** Cost Reduction Potential by Acquisition Phase

Exploration and Definition Phase, the impact of each decision is high as alternatives are considered and the most promising ones are developed further. DoDD 5000.1 assists in this regard by establishing a hierarchy of alternatives for concept exploration programs to follow.

(1) Use or modification of an existing U.S. military system;
(2) Use or modification of an existing commercially developed or Allied system that fosters a nondevelopmental acquisition strategy;
(3) A cooperative research and development program with one or more Allied nations;
(4) A new joint Service development program; and

(5) A new Service-unique development program. (17:I-3)

Some flexibility is lost as the system concept is refined during the Demonstration and Validation Phase, and alternatives that fail to meet the mission need requirement are eliminated. Decisions made establish the foundation upon which to build future cost reduction programs. The cost reduction potential of decisions made in Phase II, then, is still very high, possibly even higher than in Phase I.

The Engineering and Manufacturing Development Phase is the pivotal point in the acquisition cycle in determining the life cycle cost profile for the system. Programmatic decisions, including the structuring of cost reduction programs, determine the impact potential of those programs on overall life cycle costs. As the design is stabilized and the production processes are established and validated, the costs of production, operation, and support can be estimated more accurately. Because of the maturing process, the impact of cost reduction decisions reach a peak early in Phase III and begin to decrease.

During the Production and Deployment Phase, the program costs begin to reflect the benefits of earlier cost reduction efforts. As actual expenditures accumulate, the accuracy of both earlier cost estimates and the projected savings of cost reduction initiatives can be assessed. A moderate level of cost reduction potential still exists; however, the impact of any new cost reduction programs must be carefully analyzed.

because any cost savings from changes that significantly alter the system could be surpassed by implementation costs or by the possibility of necessary rework or retrofit on completed items.

Although the benefits from earlier cost reduction efforts continue into the Operations and Support Phase, the potential for new initiatives to impact the life cycle cost profile becomes very small. Occasionally a procedural or policy change may affect reliability or maintainability, resulting in significant cost savings; however, the determination that a system is no longer cost effective could also be the impetus to hold a Milestone V review to consider major modifications or upgrades.

*Cost Reduction Tasks.* The basic tasks required to successfully benefit from a cost reduction program are evaluation for suitability, formal planning, implementation, validation, and evaluation for effectiveness. These tasks, depending on the goals of the specific program, may begin at different times and may continue in more than one phase. As Figure 12 shows, evaluation for suitability is done in Phases I and II while alternate concepts are under consideration. Beginning in Phase II, formal planning is done for each concept, as long as that concept is viable. The planning tasks include activities such as determining required quality levels, setting reliability and maintainability parameters, and considering potential manufacturing processes. The

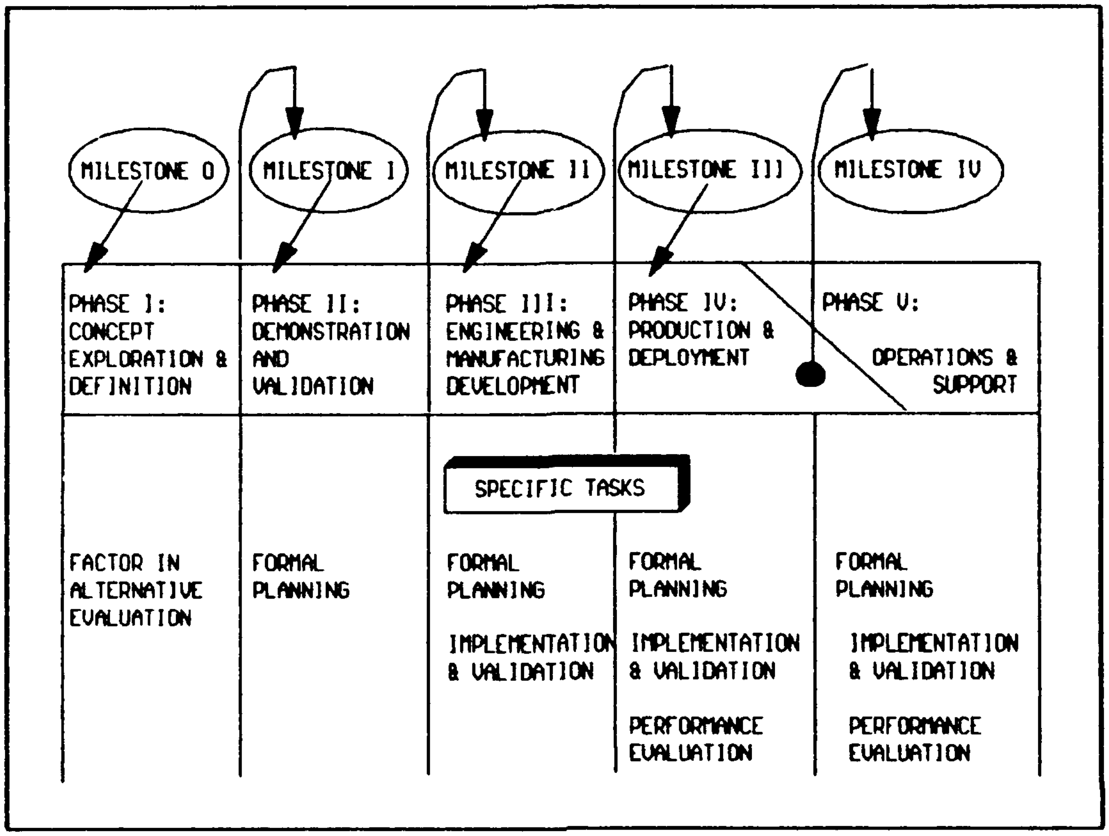


**Figure 12**. Cost Reduction Tasks by Acquisition Cycle

planning continues throughout the rest of the acquisition cycle, depending on the goals of the cost reduction program. By the end of Phase III some cost reduction programs will have been implemented and validated: others are implemented and validated in Phase IV or V. The exact timing of the implementation and validation tasks is very sensitive; if done too soon, validation may be at risk due to late design changes; if done too late, the expected benefit may become unacceptably small. Performance evaluation is done in Phase IV or Phase V or both, depending on the objectives of the cost reduction program.

*Contract Type*

Choosing the appropriate contract type is a fundamental element in controlling costs. The degree of cost risk assumed by the contractor is one of the primary factors used in selecting the contract type suitable for a specific acquisition program (11:16.101). Most of the program cost risk is assumed by the contractor when firm fixed-price contracts are used, since the government's maximum liability is determined when the contract price is negotiated (28:6.2.1b). The government assumes most of the risk on cost-plus-fixed-fee contracts, because costs are reimbursed and the fee is not affected by the actual contract costs (11:16.306). Figure 13 shows the cost risk to the contractor across the spectrum of contract types considered in this paper.

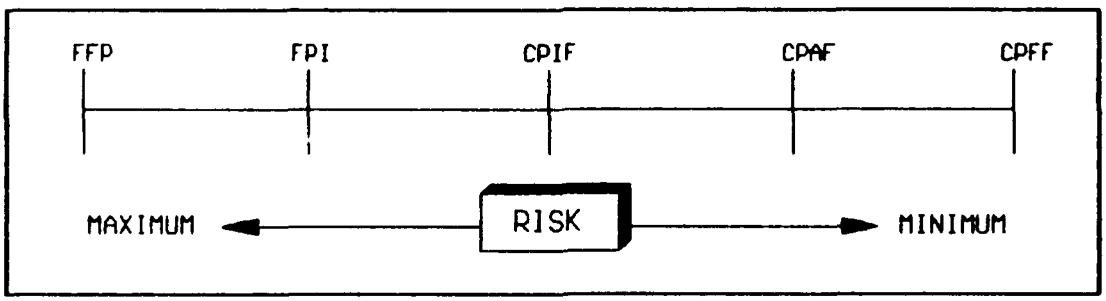


**Figure 13**. Contractor Cost Risk (28:6.2.1b)

*Cost Reduction Potential*. The cost reduction potential of each contract type is reflected in the other essential consideration in selecting contract type: the incentive the contractor has to keep costs to a minimum (11:16.101). Each contract type has its own intrinsic level of incentive for

the contractor to control costs. This natural incentive, and thus the cost reduction potential, follow the same pattern as contractor risk, as shown in Figure 14. FFP contracts provide the contractor with the greatest incentive to control

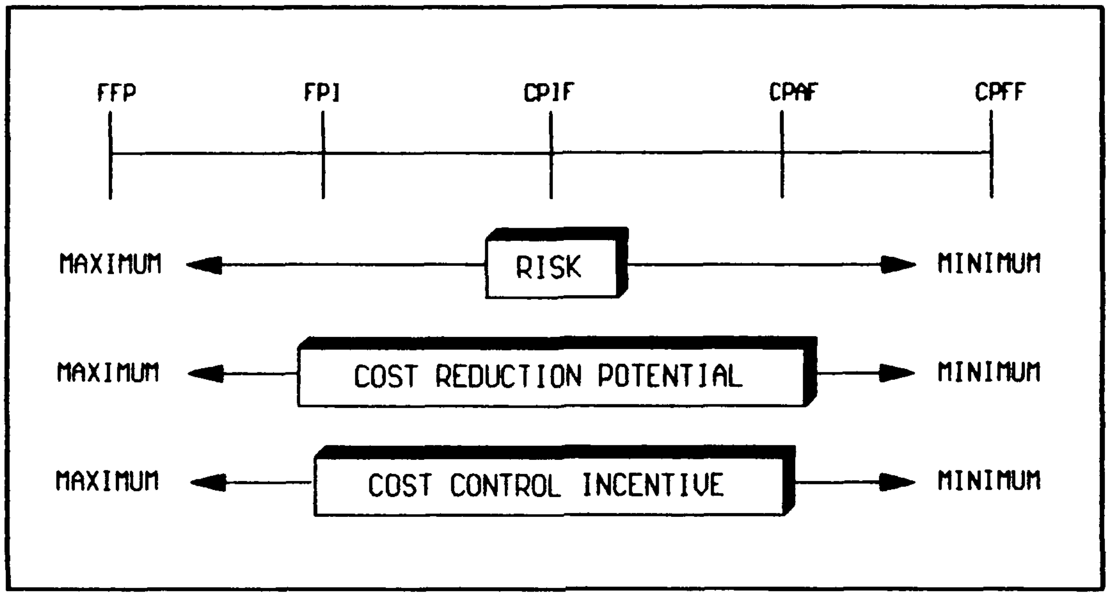


**Figure 14.** Contractor Incentive

costs, since costs replace profits on a dollar-for-dollar basis. At the other end of the spectrum, CPFF contracts provide the least incentive for the contractor to control costs. Between the two extremes, the incentive or award fee structures of FPIF, CPIF, and CPAF contracts provide the stimuli to keep costs under control. For all of the contract types except for FFP contracts, a cost reduction translates to a direct reduction in the price paid by the government. For FFP contracts, the benefit of reduced costs is realized by the government through a stronger, more profitable industrial base, and in lower prices on future contracts.

*Cost Reduction Tasks.* To realize the maximum cost reduction potential, the preeminent task is in choosing the contract type most appropriate for the acquisition program. The process of contract type selection involves careful consideration of many factors. A partial list of these factors is given in the Federal Acquisition Regulation (11:16.104):

- price competition
- price analysis
- cost analysis
- type and complexity of the requirements
- urgency of the requirement
- period of performance or length of production run
- contractor's technical capability and financial responsibility
- adequacy of the contractor's accounting system
- concurrent contracts
- extent and nature of proposed subcontracting

*Integrated Perspective.* The differences among the acquisition phases often make a given type of contract more appropriate to some phases than to others. Also, because each phase covers a different stage in the life cycle of a program, different levels of risk are involved and different types of incentives must be used in motivating contractors to control costs. The phase of the acquisition program, therefore, is an important factor in the selection of the specific contract type (27:28). Part 16 of the Federal

Acquisition Regulation contains some very specific requirements and some general guidelines on the suitability of each contract type. Figure 15 shows the types of contracts most suitable for each acquisition phase.

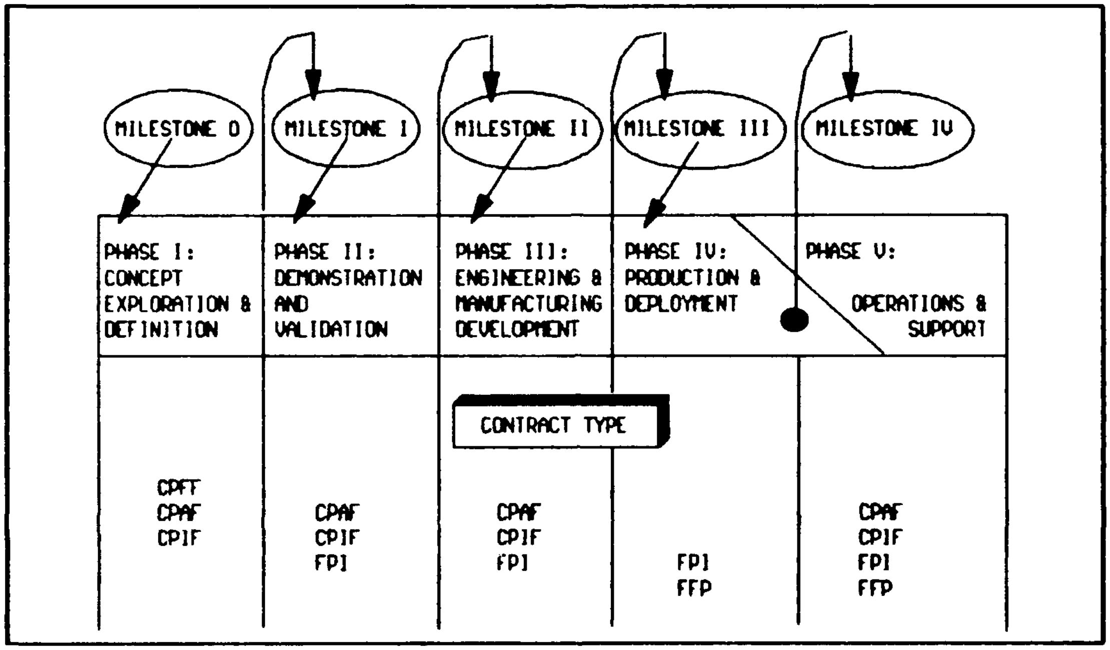


**Figure 15**. Contract Type by Acquisition Phase

The government is normally willing to assume most of the cost risk during the Concept Exploration Phase because of the immature state of the concepts under consideration. The types of contracts commonly used, CPAF, CPIF, and CPFF, reflect the greater risk assumption by the government. Throughout Phase II, proposed solutions are still not defined well enough to shift much cost risk to the contractors. Primary contract types used are CPAF, CPIF, and FPIF. During Phase III, cost risk to the government is still moderately high, but also increases for the contractor. Most contracts are CPIF or FPIF, but some CPAF types are used as well.

Since a well defined system in its production phase normally presents less of a technical risk to the contractor, it is appropriate to shift more of the cost risk to the contractor by using FFP or FPIF contract types. Operations and Support contracts are very diverse, depending on the system and the required tasks. The risks generally are not high enough to warrant a CPFF contract, but any of the other contract types might be appropriate.

*ManTech*

ManTech attempts to reduce costs by stimulating the implementation of new technologies in the manufacturing environment. DoDI 5000.2 requires that the acquisition strategy for a system include an analysis of the industrial base. The analysis must show the ability of the industrial base to develop, produce, maintain, and support the rate and quantity objectives of the acquisition program. The analysis process includes identifying current or potential ManTech programs that may be applicable (10:V-E-2).

The ManTech program has a well established record of substantial contributions to reducing life cycle costs. Because of the strict reporting requirements specified in DoDI 4200.15, data on ManTech projects are readily available. Reports must be submitted to the Defense Technical Information Center within four months of a project's completion. The Manufacturing Technology Directorate at Wright-Patterson Air Force Base also publishes reports and

pamphlets describing current and planned projects. Technical conferences and symposia are frequently used as well to publicize new technologies developed under ManTech.

*Cost Reduction Potential.* The ManTech Program attacks a specific problem in the production of goods for the DoD: a particular new technology may be promising from a cost reduction perspective, but its development and initial implementation may also present financial risks too great for the contractor to absorb. By providing government funds for the development and initial implementation of a new technology, more corporate funds are available for investment in capital equipment. Support for ManTech is evident in the fact that, while other areas of the defense budget are being reduced, the ManTech budget is being increased (29). This unique focus of ManTech provides a strong incentive to the defense industry for long term cost reduction through modernization. Specific criteria are given in DoDI 4200.15 to qualify projects for ManTech funding (14:2,3):

- the existence of a well defined defense requirement for the technology,
- sufficient time to develop the technology to meet the requirement,
- project results have the potential of being applicable to more than one end item,
- the existence of a plan to use the new or improved manufacturing technology, and
- a search for project sponsors has been accomplished in more than one DoD component.

These criteria show that the government only funds ManTech projects that have a strong probability of yielding a good return on its investment, and establish that the primary goal of any given ManTech project will be to strive for the greatest possible cost reduction potential.

*Cost Reduction Tasks.* According to Mr. R. L. Kennard, chief of the Business Management and Plans Office in the Manufacturing Technology Directorate at Wright-Patterson Air Force Base, Ohio, a ManTech project can be completed in an average of two to three years. The greatest challenge to implementing a ManTech project is synchronizing its schedule with the development schedule of the system it is planned to support. To realize its maximum benefit, a ManTech project should be complete in time for the production phase of the system. If begun too late, the project could lose some or even all of its value to that acquisition program; however, if the ManTech project is begun too soon, it could be invalidated by unanticipated system design changes (29).

*Integrated Perspective.* The precise schedule for each ManTech project will vary somewhat depending on the level of technical difficulty and when the technology is needed. Figure 16 shows how ManTech activities need to fit into the overall system acquisition cycle. The benefits from potential ManTech projects should be considered as significant factors as alternative concepts are explored in Phase I. As alternatives are demonstrated and validated in

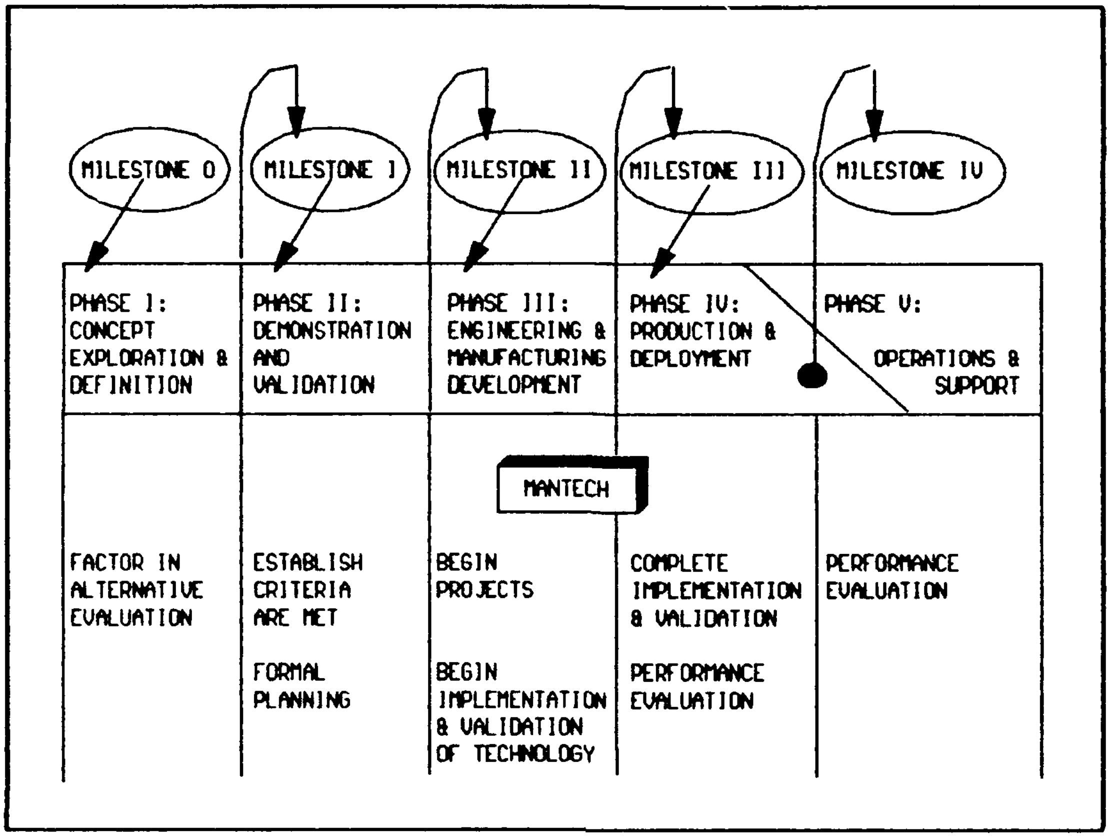


**Figure 16.** ManTech Tasks by Acquisition Phase

Phase II, any potential ManTech projects associated with promising concepts should be evaluated to establish that they can meet the criteria to qualify for funding. By the end of Phase II, formal planning should be complete for projects supporting concepts that are likely to be approved at the Milestone II review. The development, implementation, and validation of approved manufacturing technologies should begin during Engineering and Manufacturing Development to be completed by the time they are needed to support the production process. The effectiveness of the projects relative to production, operations and support, or both can be evaluated using data collected in Phases IV and V.

*IMIP*

Industrial Modernization Incentives Programs attempt to achieve cost reduction by stimulating the defense industry to install and use state-of-the-art processes and equipment. Like ManTech, the potential for using IMIPs is considered in the industrial base analysis required when formulating the strategy for acquiring a system. Since its inception in the mid-1970's, IMIP has been used frequently and effectively. Specific examples are available from the Defense Technical Information Center or through government agency IMIP focal points.

*Cost Reduction Potential*. The primary IMIP objectives are similar to those of ManTech: the reduction of acquisition costs and a strengthened industrial base. The focus of IMIP, however, is on factory-wide improvements. The incentive features described in Chapter II make IMIP a powerful tool in increasing long term cost savings on current and future programs, particularly when considering that many firms have concurrent contracts for more than one product and sometimes with more than one defense agency.

An element of awareness on the part of both the government and industry is essential for any IMIP cost reduction potential to exist. Suitable IMIP opportunities are found when managers in both industry and the government are aware of the status of contractor facilities and benefits available from technology improvements. Industry managers

must also consider the factor of corporate capital investment planning policies and objectives into any IMIP considerations.

*Cost Reduction Tasks.* The process of obtaining the maximum potential from an IMIP has two stages. The first stage is similar to the normal contracting process, as shown in Figure 17. The government and the contractor must

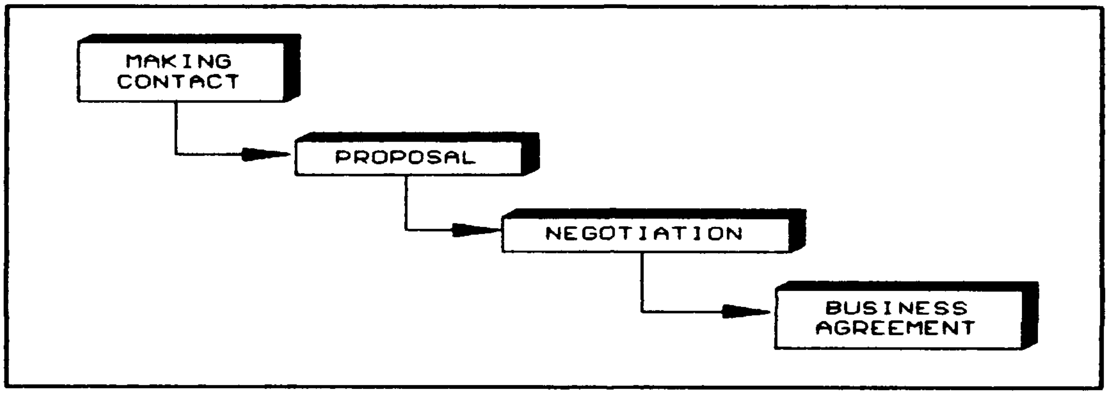


**Figure 17**. Contracting Process (12:2-3)

establish a business agreement that recognizes opportunities appropriate for IMIP funding, has realistic goals, and is fair in sharing the benefits of the program. Often the contacts are already in place through local contract administration offices or established program offices. Contacts may also be established through military department or agency focal points. A proposal to begin an IMIP may be submitted by a contractor (7:2-4):

- in satisfying a requirement contained in a program's Request for Proposal (RFP);
- through mutual agreement between the government and the contractor during the performance of a contract;

- when responding to the government through a sources sought synopsis, RFP, or competitive process;
- or through an unsolicited proposal.

Viable proposals are negotiated, leading to the business agreements. The business agreement may be a formal contract, but most often is initially in the form of an MOU, or Memorandum of Understanding (12:2-7). The MOU establishes the general intent and direction of potential IMIPs and prepares the way for future contractual activity. The contractor may conduct as much IMIP activity as desired on his own; however, early establishment of a business agreement decreases the risk of unproductive efforts. By conducting cost-benefit analyses and developing specific IMIPs within the context of the business agreement, unnecessary disputes and surprises can be avoided.

The second stage involves the actual implementation of a specific IMIP. As shown in Figure 18, the business agreement

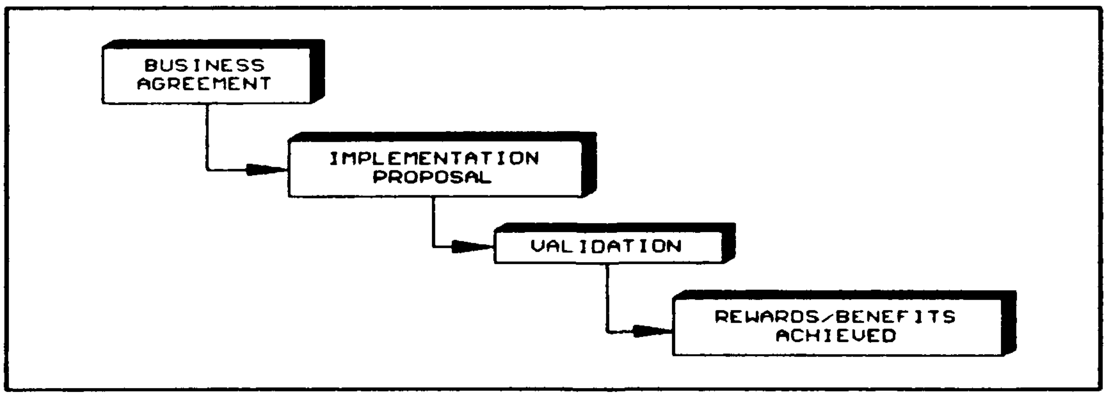


**Figure 18.** IMIP Implementation (12:2-9)

provides the basis for implementation proposals. The Implementation Proposal includes all information necessary to

evaluate an IMIP that has been developed. Once approved, the modernization program can be validated for use in achieving its intended benefits and rewards.

*Integrated Perspective.* An IMIP could be developed to benefit any phase of the acquisition cycle; therefore, how an IMIP schedule looks against a system acquisition schedule depends on the specific IMIP objectives and when the modernization effort must be in place to realize the maximum benefit. Similarly, any of the contract types could contain a requirement for, or receive the benefits from an IMIP effort.

A very significant relationship does exist between IMIP and ManTech. Their objectives, productivity improvements and better responsiveness in the defense industry, are similar, and they can be used to complement and support each other. As shown in Figure 19, an IMIP can be used to implement a

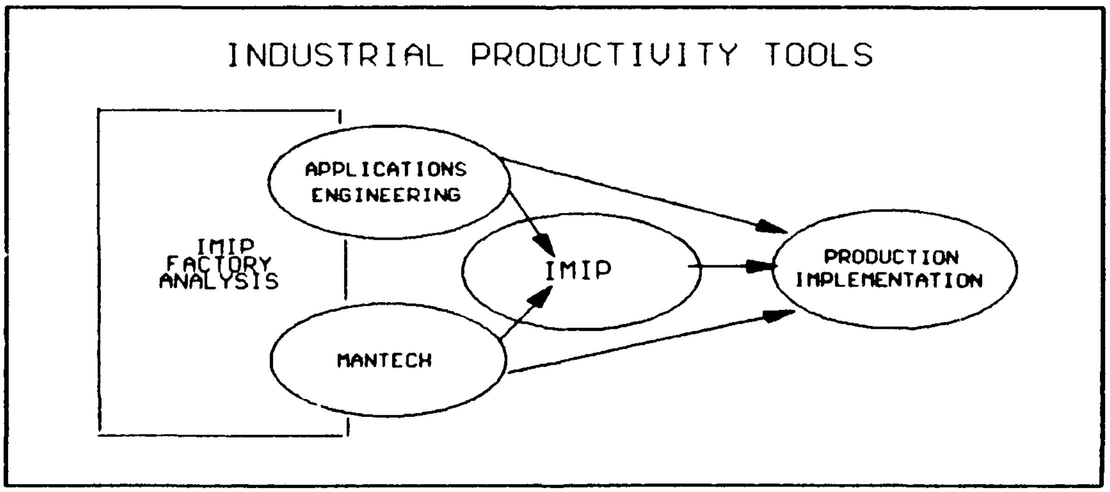


**Figure 19.** IMIP/ManTech Relationship (12:1-7)

successful ManTech project, or an IMIP factory analysis may reveal the need for a new technology best suited for the ManTech Program (12:1-6).

Since IMIP and ManTech are sometimes confused, understanding differences between the programs is important. The distinguishing features of IMIP and ManTech are shown in Table 3. Understanding the appropriate use of each program enhances the manager's efficiency in implementing cost reduction ideas.

Table 3

IMIP & ManTech Differences

| FEATURE | IMIP | MANTECH |
| --- | --- | --- |
| Improvement applications | Factory wide | First case |
| Technology | Both well developed and state-of-the-art | High risk |
| Funding source | Contractor, government, or both | Government |
| Incentives | Market based and shared savings | Speeds return on capital investments |
| Investment/ Implementation Commitment | Established in the business agreement | No commitment exists |

*Value Engineering*

Value Engineering attempts to reduce costs by eliminating costly system requirements that do not contribute to required system performance. At its essence, it is a

functional analysis of an item to determine if the essential functions can be achieved in a more cost effective manner.

*Cost Reduction Potential.* Although VE may be applied any time in the acquisition cycle, in general, more net savings will be realized the earlier VE changes are implemented. This principal is demonstrated in Figure 20.

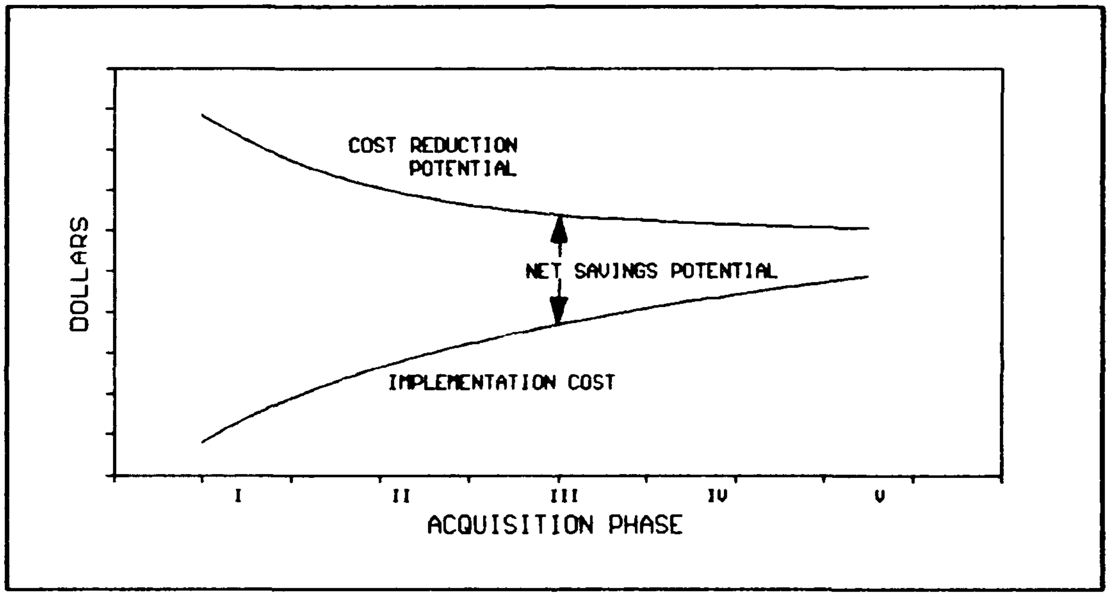


**Figure 20.** VE Savings Potential (18:2-3)

As discussed in the section analyzing the acquisition cycle, the cost reduction potential is higher in the earlier program phases. As the system design becomes more defined, fewer cost reduction changes are possible. Simultaneously, costs to implement changes increase, because of factors such as:

- retooling;
- production line changes;
- retesting materials, parts, or products;
- revalidation of affected processes;

- rework of completed/partly completed parts or products;
- unsalvageable completed/partially completed parts or products;
- unusable material or parts already purchased;
- documentation changes;
- changes to operational support items.

Other factors are involved in the process, however, which act to push implementation of VE changes toward the later program phases.

- In the earlier phases, requirements are just in the process of being defined, and change proposals are neither appropriate nor possible.
- The criteria necessary for a fair evaluation of a proposed change are generally not yet available.
- Most value engineering ideas result from experience in working with the system - experience which increases as the system moves into later acquisition cycle phases.

The precise timing appropriate for any given change proposal, then, will vary according to the particular objectives of and circumstances surrounding that proposal.

*Cost Reduction Tasks.* The following general activities are necessary to have an effective VE program.

- Establish the environment and the mechanism for VE as early as possible.
- Encourage the submission of proposals throughout the life of the system.
- Consider proposed changes as early as the criteria necessary for a fair evaluation are available.
- Reward the initiator of the proposal as soon as possible after the proposal's approval.
- Schedule the implementation of approved changes to capture the maximum net savings.

*Integrated Perspective.* Since a VE clause is required on every major systems acquisition contract, the full spectrum of contract types comes into play from a VE perspective. The VE incentive payments, when combined with the increase in profit or fee expected to accompany a decrease in cost, become a powerful tool in encouraging the contractor to invest in the innovation required to be efficient without sacrificing effectiveness.

VE also works cooperatively with both ManTech and IMIP: the incentive features of VE and IMIP are similar; potential VE suggestions could be discovered while conducting an IMIP factory analysis or a ManTech/IMIP industrial base analysis; or an initiative begun under VE could turn into an IMIP if factory-wide applications are present. The possibility exists that a specific suggestion could be implemented through either VE or IMIP. Recognizing the particular focus of VE on contractual requirements changes, however, helps clarify which of the cost reduction methods is appropriate.

The functional analysis tasks of a VE program fit nicely within the acquisition cycle framework. *DoD 4245.8-H, Value Engineering,* breaks out specific VE tasks by acquisition cycle phase as shown in Figure 21 (18:2-4,2-5). First, if no VE organization already exists, one must be formed early in Phase I. The VE organization then assists in the concept exploration studies with a mission to obtain the most economical program and design decisions. During Phase II, the VE role is expanded to analyze the operations,

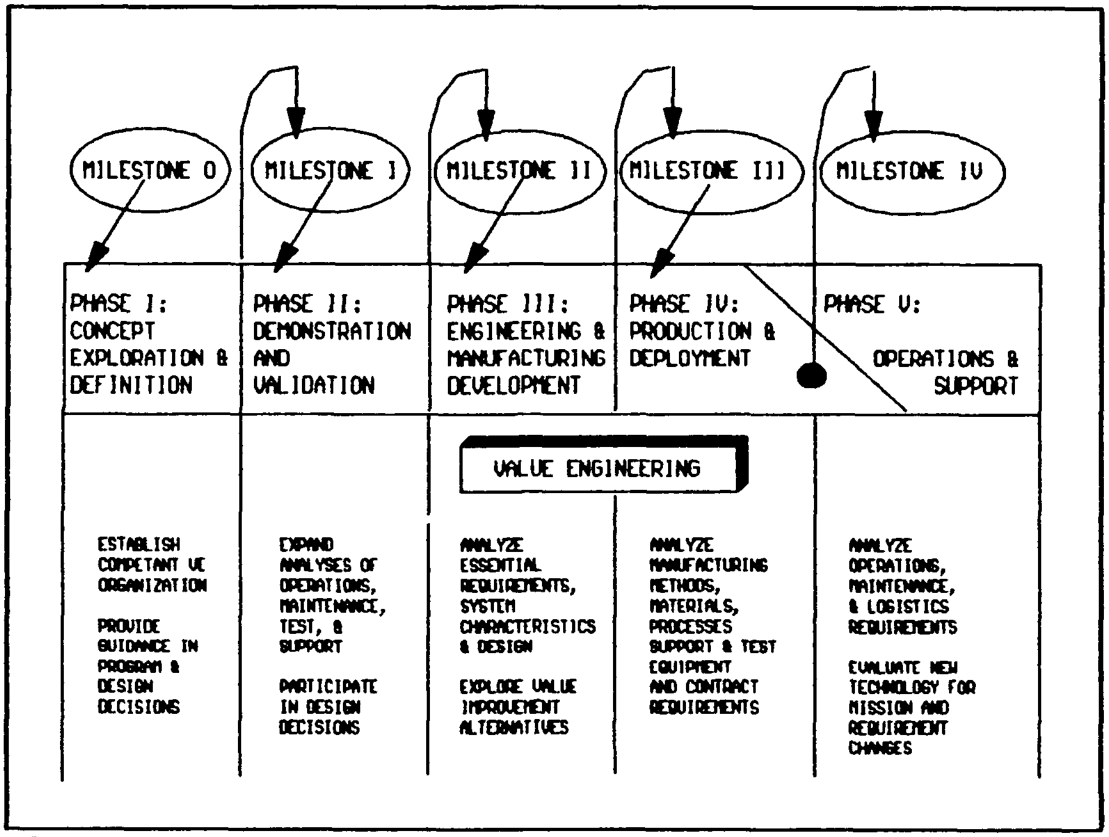


**Figure 21.** Value Engineering Tasks by Acquisition Phase

maintenance, test, and support functions of each alternative under consideration. Up to this time, the functional analyses are primarily involved in assisting in the selection of the most cost effective alternative, rather than suggesting changes to established requirements; therefore, paying the contractor for his efforts under the VEPR approach is appropriate. In Phase III, VE analyzes the essential system requirements, the system characteristics, and the design parameters selected, and explores alternatives that might improve the system's value. Production activities in Phase IV offer the opportunity for VE analyses of manufacturing processes, methods, and materials. Support and

test equipment requirements and design can also be analyzed. Contract requirements should be sifted as well to find any that can be eliminated with no impact on the system's mission performance capabilities. Finally, in Phase V, operation and maintenance procedures, along with other logistics requirements, can be reviewed. Opportunities may arise to incorporate new technologies, or to consider the impact of mission changes or different system requirements. VE has been credited with cost reduction in Phase V as a result of changes that extended the life of an item, reduced repair costs, reduced packaging costs, and eliminating unneeded items altogether (18:2-5).

*Producibility*

As an integral part of the design process, producibility is a characteristic of an item that has a vital part in determining the item's life cycle cost. Within the manufacturing management discipline, the producibility process evaluates the evolving design, and recommends changes and improvements to ensure efficient and effective production runs. Producibility programs play a vital role in determining the degree of difficulty or ease with which a program transitions from development to production. The greatest cost benefits of producibility, therefore, are realized during the production phase.

*Cost Reduction Potential.* As stated earlier, the goal of producibility efforts is to reduce costs of production.

With an effective program, the cost reduction potential can impact much more than just the manufacturing process. Some areas likely to benefit from a producible item are:

- reliable delivery schedules, decreasing the costs of delays and idle time;
- producible spare parts, increasing the supportability of the end item; and
- increased quality, reducing the cost of inspection resources.

*Cost Reduction Tasks.* The first essential producibility task is planning. The importance of the planning function is evidenced by the recommendation in MIL-STD-1528A, *Manufacturing Management Program,* that the Manufacturing Management Plan be included in the contract data requirements list. Proper planning ensures that the other producibility tasks are accomplished. Another producibility task is the identification and resolution of manufacturing risks. This task involves analyses of the system requirements and the ability of the available resources to produce items to meet those requirements. Producibility, therefore, is a prime consideration is any potential system design.

*Integrated Perspective.* Even though there are no DoD-wide programs that provide financial incentives specifically for achieving producibility goals, producibility objectives can form a link to other incentive-driven cost reduction methods. All contracts involving production activities, or leading to the production of defense systems, are required to

address producibility issues; therefore, producibility applies to all the contract types. If producibility issues present significant technical risks to the contractor, however, one might expect to see a tendency toward cost reimbursement type contracts. Incentive or award payments in FPIF, CPIF, and CPAF contracts could be used to reward achievement of producibility goals. If producibility analyses indicate the need to develop new manufacturing technologies or the need for a modernization program, a ManTech project or an IMIP could be used to satisfy the producibility requirements. Likewise, a VECP may be used to propose producibility-enhancing changes to specified processes or materials.

Producibility activities are also time-phased within the framework of the acquisition cycle, as shown in Figure 22. Any producibility issues relevant to design approaches and manufacturing processes under consideration during Phases I and II must be considered. During Phase II, a producibility program is established to provide three things by Milestone II: a producibility assessment of the emerging design; actions already taken to reduce risk in the manufacturing processes; and a plan to validate any new or critical manufacturing processes. In Phase III, any unproven or high risk elements of the manufacturing system are identified, and specific steps are taken to address each one. Producibility is a critical part of the two major elements of Phase III: the development of the final design, and validating the

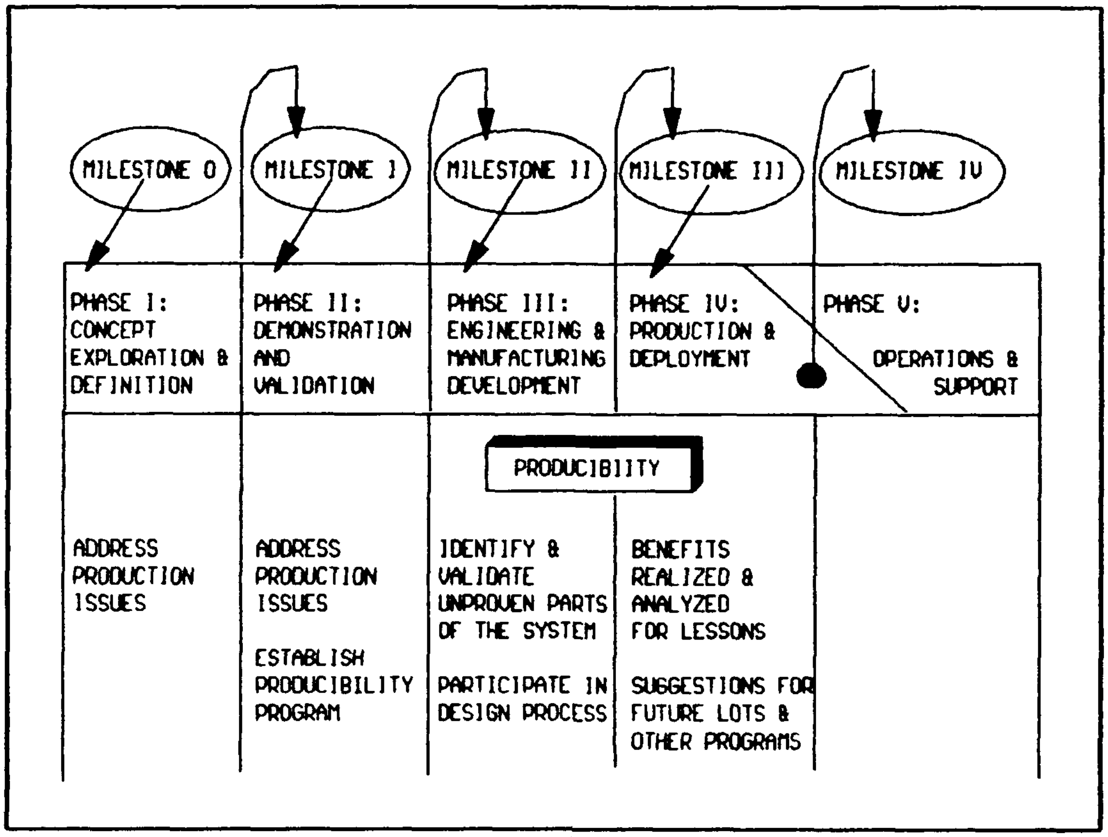


**Figure 22.** Producibility Tasks by Acquisition Phase

manufacturing process. The degree of efficiency experienced in the production phase is a measure of the effectiveness of the producibility program. If the production run is long or in multiple lots, it may be possible to make further producibility improvements with lessons this phase provides. Lessons learned may also be applied to future programs.

*Reliability*

Like producibility, reliability is an indispensable part of the design process. Reliability requirements may dictate the use of certain components, processes, or materials in the system design. Typically, the degree of reliability achieved by a particular design is verified by conducting various

tests. Since test failures can be very costly, or even fatal to an acquisition program, the design of the reliability tests becomes very important as well.

*Cost Reduction Potential*. From a management perspective, the life cycle costs model must be used when considering reliability goals. More stringent reliability goals usually increase the development and acquisition costs of a system early in the life cycle, but result in lower operating and support costs in the later life cycle phases. Therefore, to realize the cost reduction potential of system reliability, upper management, both in industry and in the government, must view the cost of reliability goals as an investment in lower life cycle costs rather than a cost of manufacturing.

From a technical perspective, the overall system reliability is an accumulation of individual component and subsystem reliabilities. Therefore, the cost reduction potential of any given reliability program is heavily dependent on factors such as

- level of resource investment in the planning and design stages of development,
- design discipline within an organization,
- the overall system reliability objectives, and
- the relative importance of individual component subsystem reliability requirements.

It should be noted that reliability programs are normally established early in the acquisition process.

Commonly, reliability goals are set conservatively high, in part because the design is not yet well characterized. As the system design matures, it may prove to exceed the reliability requirements. As the operational performance objective take shape, requirements could change. Under conditions such as these, additional cost reduction potential exists in the form of adjusting or eliminating reliability requirements to conform to real system capabilities and real operational requirements.

*Cost Reduction Tasks.* Specific reliability programs are structured based upon operational requirements, the type of system being developed, and where the system is in the acquisition cycle. MIL-STD-785B, *Military Standard Reliability Program for Systems and Equipment Development and Production*, suggests specific tasks in the general areas of program surveillance and control, design and evaluation, and development and production testing (16:6). Typically, the contractor is required to "establish and maintain a reliability program in accordance with" a tailored version of MIL-STD-785B. The "tailoring" involves identifying specific MIL-STD 785B tasks and perhaps others as well that apply to the system.

*Integrated Perspective.* Reliability interfaces with the other cost reduction methods in much the same way as producibility does. Reliability programs are applicable to all system development contracts. Technical risks introduced

by reliability requirements might lead to the use of more cost reimbursement type contracts. Reliability goals could also be established as criteria in determining incentive or award fee payments. ManTech or IMIP could be used to help achieve reliability goals. Reliability objectives can also be the basis for VE incentives, either in reaching the goals of the reliability program, or in eliminating requirements.

Reliability and producibility also sometimes compliment each other. For example, a simple design with a minimum number of parts, or a design using off-the-shelf parts with well established reliability characteristics, contribute to higher reliability and better producibility. At times, however, methods of achieving reliability requirements make the design less producible. For example, redundant and back-up systems, often required to reach reliability requirements, can complicate producibility by increasing number or complexity of components used. If physical constraints such as volume or weight exist, the increased design complexity can increase the risk to both reliability and producibility.

Throughout the entire acquisition cycle, reliability objectives are based on operational requirements. Other specific activities within the framework of the acquisition cycle are shown in Figure 23. In the first two phases, objectives are defined for the alternatives under consideration. In Phase III, as the system design is developed, the results of reliability tests and failure analyses, are used to help evaluate and solidify the design,

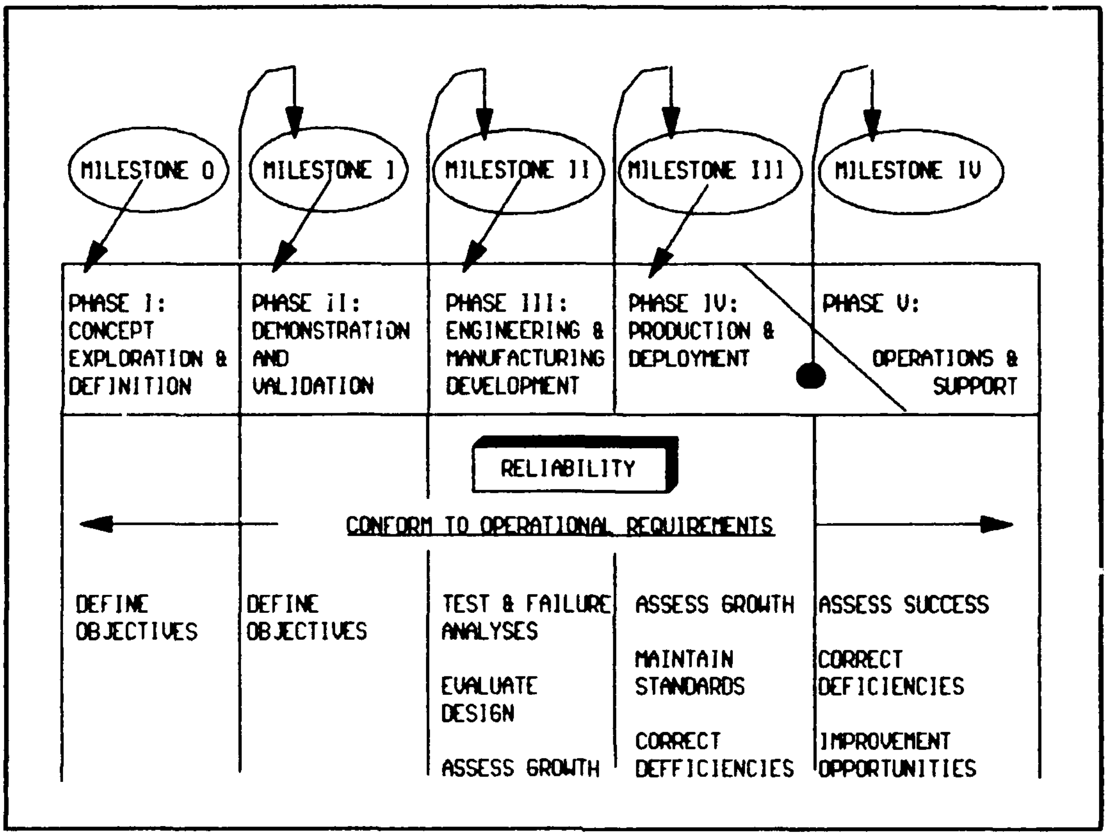


Figure 23. Reliability Activities by Acquisition Phase

and to assess reliability growth. The reliability growth assessment continues into Phase IV with more testing. During production, reliability standards are maintained by careful parts screening to eliminate manufacturing defects and by preventing tolerance buildup (10:VI-C-4). In Phase V, actual reliability performance is measured to assess success of reaching the desired objectives, and to ensure that the reliability standards do not degrade. Opportunities to further improve system reliability are perused, often through suggestion programs.

The actual reliability of fielded military systems often fails to match the results of verification tests done prior

to delivery. Among the reasons cited for poor field performance are (3:73):

1. Performance requirements often dictate the use of advanced or revolutionary technology before reliability characteristics are determined.

2. Schedule constraints prohibit the use of iterative designs and complete testing.

3. The harsh environments where military systems are used are difficult to duplicate in the design or test laboratory.

4. The stress of the operational environment can cause unexpected operator errors.

5. Operators and maintenance personnel often lack experience.

6. Actual field conditions often preclude the use of manufacturer recommended spares, spares storage and handling, and maintenance procedures.

### *Maintainability*

Since the costs of operations and maintenance frequently out-pace all other cost categories, an easily maintained system is highly desirable. Maintainability, therefore, is another essential design parameter.

*Cost Reduction Potential.* As with reliability, a life cycle cost perspective is necessary to recognize the cost reduction potential of maintainability programs. Studies have shown that if a reasonable balance between reliability and maintainability is reached, and that if maintainability is designed into the system, acquisition costs may be higher, but operating costs will always decrease. The net impact is lower life cycle costs. The cost saving are a result of

fewer man-hours spent on maintenance, fewer required spares, and improved operational availability of the system (21:31).

*Cost Reduction Tasks.* Maintainability programs are structured in much the same way as reliability programs. Specific tasks, tailored to the specifics of the system and the acquisition phase are established as contractual requirements. The maintainability objectives must be based on operational requirements. Some detailed task descriptions are suggested in MIL-STD-470B, *Military Standard Maintainability Program for Systems and Equipment.* Three general categories of tasks are given: Program Surveillance and Control, Design and Analysis, and Evaluation and Test.

*Integrated Perspective.* The interplay of maintainability with the various contract types, ManTech, IMIP, VE, and producibility is practically the same as for reliability. A yet stronger link exists between reliability and maintainability: one hardly hears reference made to one without including the other. They can have positive or negative effects on each other and on the producibility of a system. Parametric trade-off studies are often necessary in determining the optimum set of maintainability and reliability goals (21:30). For example, maintenance requirements may introduce extra parts which have testing and servicing needs, thus reducing reliability. Also, providing the accessibility needed to increase maintainability of a weapon system may adversely affect the design from a

reliability perspective. On the positive side, a more reliable system needs fewer routine maintenance checks; and a more maintainable system often breaks down less frequently, thus increasing reliability (24:90). These issues are addressed by establishing integrated but distinct reliability and maintainability programs with the following common overall goals (16:4 and 15:5):

- improve operational readiness,
- reduce logistic support requirements,
- reduce life cycle costs, and
- provide essential management data.

The acquisition cycle interface with maintainability is shown in Figure 24. Program objectives are defined for each alternative in Phases I and II. The objectives must be based on operational requirements, and be expressed in definable terms. Before the detailed design of a system is completed in Phase III, maintainability analyses are accomplished. The analysis results are used to help develop specific maintainability design criteria for the system. As design testing begins, maintainability growth is assessed. DoD Instruction 5000.2 also requires that a maintainability demonstration be conducted before Milestone III to verify that the objectives have been met. In Phases IV and V, the maintainability growth assessment is continued. The experiences of use in the operational environment are used tomeasure how well the maintainability design objectives were achieved.

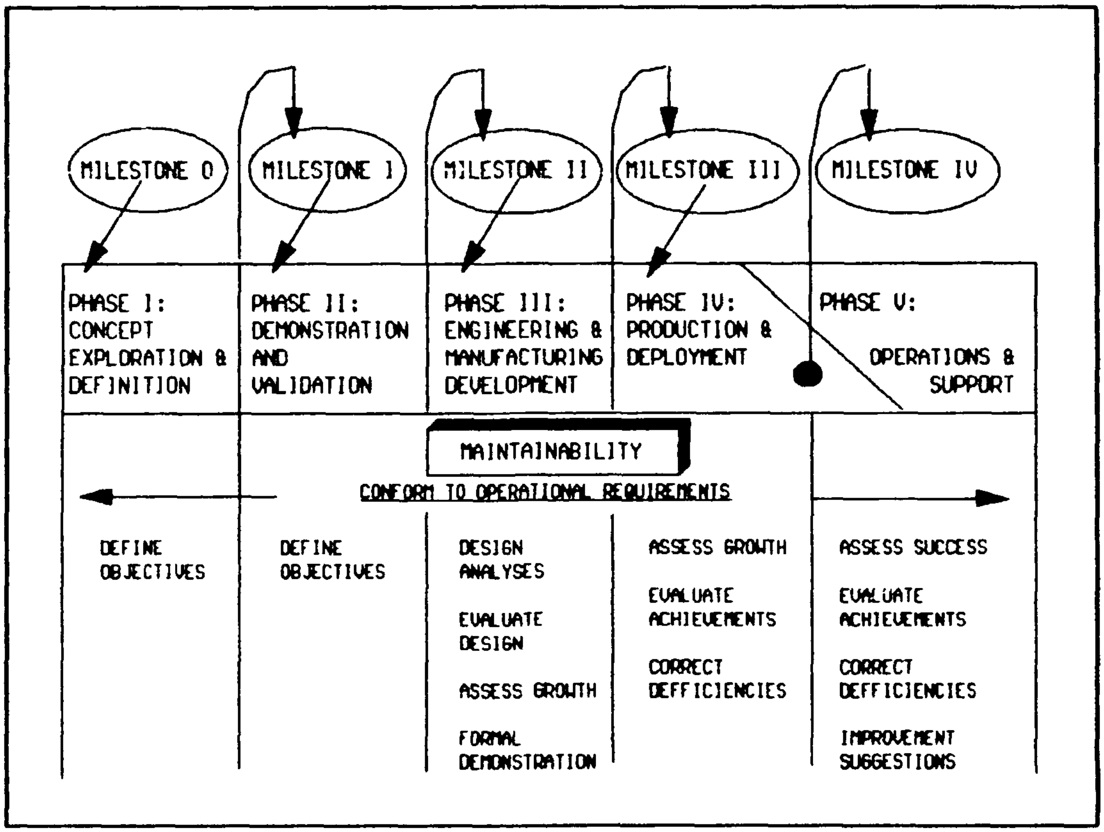


**Figure 24.** Maintainability Activities by Acquisition Phase

*Summary*

This chapter demonstrated the interaction found among the cost reduction methods. As stated in the DoD guide for IMIP:

> A number of acquisition tools ... are available to contract for a viable cost reduction program. ... [N]o one formula exists that can be used for all acquisition situations. Every acquisition is different and no one single contract strategy can be devised for application across the broad spectrum of defense contracting. Ingenuity and creativity are encouraged in constructing a viable program. (12:1-4)

# V. *Conclusions and Recommendations*

## *Chapter Overview*

The purpose of this chapter is to set forth conclusions and recommendations drawn from the study. In presenting the conclusions, first the research problem is restated. The findings in the area of each research objective are then summarized. Next, general conclusions covering the study as a whole are given. Finally, possible follow-up activities suggested by the study are recommended.

## *The Research Problem*

The thrust of this thesis was to enhance the ability of acquisition program managers to understand and use several incentive-driven cost reduction methods. The primary issues that surfaced in the course of the analysis were how the various methods were interrelated, and the importance of considered, time-phased activities necessary to fully realize their full cost reduction potential.

*Research Objective #1.* The first objective was to review the phases and milestones of the acquisition cycle. The recent revisions to DoD Directive 5000.1 and DoD Instruction 5000.2 made this objective a valuable exercise in itself. With respect to the research problem, an understanding of the acquisition cycle is essential, because it forms the basic framework for all activity in the acquisition process.

*Research Objective #2.* The second objective was to study the primary contract types used on major weapon system acquisition programs. The most obvious finding was that any of the contract types could employ any of the cost reduction methods, either singly or in combination with other methods. While this discovery may not appear to be very profound, it is still quite important, particularly when the risk in performing the contract can be decreased by including one or more cost reduction methods on the contract. When the factor of financial incentives is included, the cost reduction methods can become important tools in negotiating the type of contract to use.

*Research Objective #3.* The third objective was to study the individual characteristics of the cost reduction methods. In a broad sense, all the cost reduction methods were found to be aimed at smoothing the transition from development to production. ManTech and IMIP are used to address industrial base modernization issues. VE is used to eliminate unnecessary requirements. Producibility, reliability, and maintainability are used to ensure requirements with critical design implications are addressed early enough to be both included in the design and cost effective. In a narrower sense, each cost reduction method was found to be designed to focus on very specific issues in the acquisition process, as indicated in Table 4. Each method was also found to be

Table 4

Focus Issues of the Cost Reduction Methods

| COST REDUCTION METHOD | FOCUS ISSUE |
| --- | --- |
| ManTech | Development and implementation of new manufacturing technologies |
| IMIP | Plant-wide modernization |
| Value Engineering | Elimination of costly, nonessential requirements |
| Producibility | Decrease risk in production processes, methods, and materials |
| Reliability | Increase probability system will perform as desired |
| Maintainability | Increase probability system will be available when needed |

individually effective at cost reduction when directed toward its own intended focus.

*Research Objective #4.* The fourth objective was to analyze the interrelationships among the elements of the study. The acquisition cycle was found to be the only true independent variable in the analysis. A strong link to the acquisition cycle was found with each element of the study:

- the phase of the program is an important factor in selecting the appropriate contract type;
- activities specific to the various cost reduction methods are required in each phase of the cycle to fully realize cost reduction benefits.

The type of contract, while partially dependant on the acquisition cycle, was neither dependant on, nor exerted direct influence over, any of the cost reduction methods. Some indirect links were found, however, particularly as

incentive and award fees can be based on achievement of goals or requirements of the cost reduction methods.

The cost reduction methods were found to be interdependent to a very large extent. The following types of interdependencies were noted.

- One method continued the cost reduction activity begun under another method. Example: an IMIP is used to implement a ManTech project.
- An analysis done under one method suggested an opportunity to use another method. Example: a producibility analysis finds a ManTech project is appropriate.
- Actions generating cost savings under one method had negative cost implications from the perspective of another method. Example: trade-off analyses are necessary to determine producibility, reliability, and maintainability objectives.
- A cost reduction method was used to implement actions that satisfied the objectives of another method. Example: a VECP is submitted proposing the requirement to use a specific process be eliminated in favor of a more reliable process.

*Research Objective #5.* The fifth objective was to provide an integrated framework for considering alternative cost reduction methods to apply in specific situations. The framework offered is in the form of five considerations the author believes re relevant in matching a cost reduction method with a cost reduction candidate. These considerations are listed in Figure 25. First, the program environment must be understood, including the relative position of the program in the acquisition cycle and the contract type. Other programmatic environmental considerations not discussed in this paper are the financial status of the program, its

PROGRAM ENVIRONMENT

FOCUS

PRACTICALITY

INTERRELATIONSHIPS

IMPACT

**Figure 25**. Cost Reduction Considerations

urgency or priority, and political concerns. Second, possible cost reduction methods should be considered to match the focus of the cost reduction candidate. Third, the practicality of the possible cost reduction methods should be considered from a time and resource perspective. Fourth, the impact of the new effort to other cost reduction programs already in effect should be considered. Finally, the overall impact on the risk and incentive structure of the program should be evaluated.

*General Conclusions*

The task of putting a cost reduction candidate to work is complex. To do so requires an understanding of how the different cost reduction methods work. The cost reduction methods discussed in this thesis have proven themselves to be effective when used correctly and appropriately. The incentive features can be powerful tools in strengthening the defense industry.

*Recommendations*

1. Other researchers should continue research in the general problem area this thesis addressed. Examples of empirical studies that could be done among the system program offices are:

- measure the historical effectiveness of each cost reduction method individually;
- determine how the various cost reduction methods have been combined for effective cost management; and
- survey senior program managers in the Department of Defense and in industry to obtain expert opinion on specific problems in implementing cost reduction programs.

2. Studies similar to this thesis should be conducted to cover other cost reduction methods. Examples of other cost reduction methods which could be studies are quality programs, design-to-cost, supportability, and transportability.

3. Expert systems should be developed to assist system program office personnel in managing cost reduction studies. Specifically, expert systems could help the program manager:

- implement cost reduction candidates under appropriate cost reduction programs;
- assess cost reduction potential of a cost reduction candidate or program;
- search for deficiencies in cost reduction programs;
- plan cost reduction programs;
- select appropriate contract type;
- set appropriate incentive and award fees;
- select appropriate incentive and award fee evaluation criteria.

4. Course curricula used to educate and train program managers should be reviewed to ensure these cost reduction methods are included. Having a comprehensive grasp of cost reduction techniques would make a significant contribution to increasing the program manager's ability to deal with his highly complex environment.

With the degree of uncertainty that exists in the defense acquisition arena, two things are certain: the opportunity will always exist to study the impact of some element that just changed or is about to change; and those individuals charged with managing defense acquisitions will need the erudition that comes from such research.

*Appendix: Cross-Reference of New to Former Acquisition Phases & Milestones*

| PHASES & MILESTONES | NEW TERM | FORMER TERM |
|---|---|---|
| Phase I | Concept Exploration & Definition | Concept Exploration/ Definition |
| Phase II | Demonstration & Validation | Concept Demonstration/ Validation |
| Phase III | Engineering & Manufacturing Development | Full-Scale Development/Low Rate Initial Production |
| Phase IV | Production & Deployment | Production/Deployment |
| Phase V | Operations and Support | Support & Readiness |
| Phase VI | Deleted | Upgrade/Replacement |
| Milestone 0 | Concept Studies Approval | Program Initiation/ Mission-Need Decision |
| Milestone I | Concept Demonstration Approval | Concept Demonstration/ Validation Decision |
| Milestone II | Development Approval | Full-Scale Development Decision |
| Milestone III | Production Approval | Full Rate Production Decision |
| Milestone IV | Modification Approval | Logistics Readiness & Support Review |
| Milestone V | Deleted | Major Upgrade or System Replacement Decision |

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# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | September 1990 | Master's Thesis |

**4. TITLE AND SUBTITLE**
AN ANALYSIS OF INCENTIVE-DRIVEN COST REDUCTION METHODS FOR MAJOR WEAPON SYSTEM ACQUISITION PROGRAMS

**5. FUNDING NUMBERS**

**6. AUTHOR(S)**
Daniel W. Sietman, Captain, USAF

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Air Force Institute of Technology
WPAFB, OH 45433-6583

**8. PERFORMING ORGANIZATION REPORT NUMBER**
AFIT/GSM/LSP/90S-27

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION/AVAILABILITY STATEMENT**
Approved for public release; distribution unlimited

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)* This thesis investigated the framework of the acquisition cycle, the primary types of contracts used in major weapons system acquisition programs, and several incentive-driven cost reduction methods. The cost reduction methods studied were the Manufacturing Technology Program (ManTech), the Industrial Modernization Incentives Program (IMIP), Value Engineering (VE), Producibility, Reliability, and Maintainability. The goal of the research was to provide a framework to help program managers better understand the cost reduction potential of, and the interrelationships among, the study elements, when attempting to implement specific cost reduction candidates. The research revealed a strong link between the acquisition cycle and each of the other study element, some indirect links between the various contract types and the cost reduction methods, and a number of interdependencies among the cost reduction methods. The framework developed consisted of five issues to consider: (1) the program environment, (2) the focus of the cost reduction candidate versus that of each cost reduction method, (3) the practicality of cost reduction methods, (4) the interrelationships among all cost reduction methods in use, and (5) the overall impact on the risk and incentive structure of the program.

**14. SUBJECT TERMS**
Incentive Contracts, Manufacturing, Value Engineering, Production Engineering, Reliability, Maintainability

**15. NUMBER OF PAGES**
98

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
|---|---|---|---|
| Unclassified | Unclassified | Unclassified | UL |